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Need-to-know trends

TECHNOLOGY / BUSINESS GOVERNMENT / MEDIA SCIENCE / ENVIRONMENT MEDICINE / LIFESTYLE

Written by

MELINDA GATES, YVES BÉHAR, REID HOFFMAN, ALAIN DE BOTTON, RORY SUTHERLAND, DAN ARIELY AND MANY MORE

2016

148 PAGES OF ESSENTIAL DATA TO FUTURE-PROOF YOURSELF AND YOUR BUSINESS
99 IDEAS THAT WILL CHANGE THE WORLD 32 THINKERS SHARE THEIR INSIGHTS

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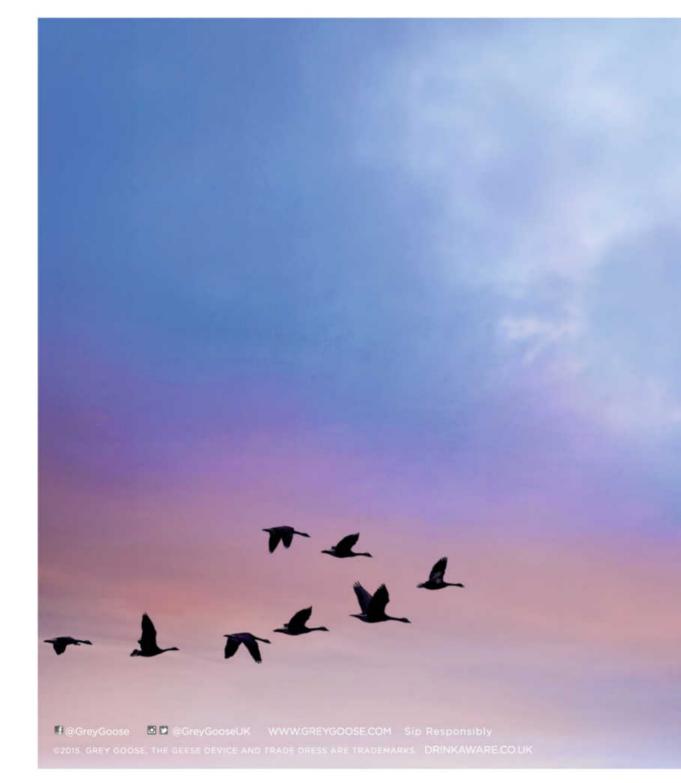








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GEAR

The Audi Prologue is no mere flight of fancy – much of its technology, including a dashboard-sized touchscreen, is making the leap from concept to retail vehicles in 2016. Plus: Sony's PlayStation VR – and a slew of rival headsets; Maxime Loiseau's minimalist headphones; the KEECKER home-patrolling egg-bot; and yes, a real-life hoverbike

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A few of the people who made The WIRED World in 2016 possible



GREG WILLIAMS

"We're fortunate to have contributions from some of the world's smartest thinkers in this issue. It has allowed us to create a powerful, future-facing resource," says Williams, editor of The WIRED World in 2016. In this year's edition, members of the WIRED network - from designer Stefan Sagmeister to collaborative consumption specialist Rachel Botsman - have identified significant trends that will impact in a meaningful way. "Twelve months from now, there'll be some idea or business discussed in these pages that we'll be taking for granted."



NATALIE MASSENET

The Net-a-Porter founder has a trend for 2016 – collaboration between competitors: "Successful businesses will be characterised by collaboration," she says. "With others in their sector, different sectors, or with customers."



MARK WEAVER

The Technology section is illustrated by New York-based Weaver. "I've developed a retro-futuristic mid-century style," he says. "The idea here was to convey a feeling of something familiar, but at the same time unusual."



MELINDA GATES

-

The co-founder of the Bill & Melinda Gates Foundation writes in our Government section on how data can save lives. "2016 will mark a sea change in how developing countries harness the true power of data to improve their citizens' lives." she savs.



SAWDUST

Typographers Rob Gonzalez and Jonathan Quainton provide our striking section numbers. "Dimensionality, form and ethereal spaces inform our work," says Gonzalez. "We push lettering to be more like sculptures." adds Quainton.



JANNE IIVONEN

-

livonen illustrates the Medicine section: "I wanted to achieve a sense of clarity and optimism that echoed that of the features," he says. "There's a feeling that the way we approach healthcare is about to totally change."



REID HOFFMAN

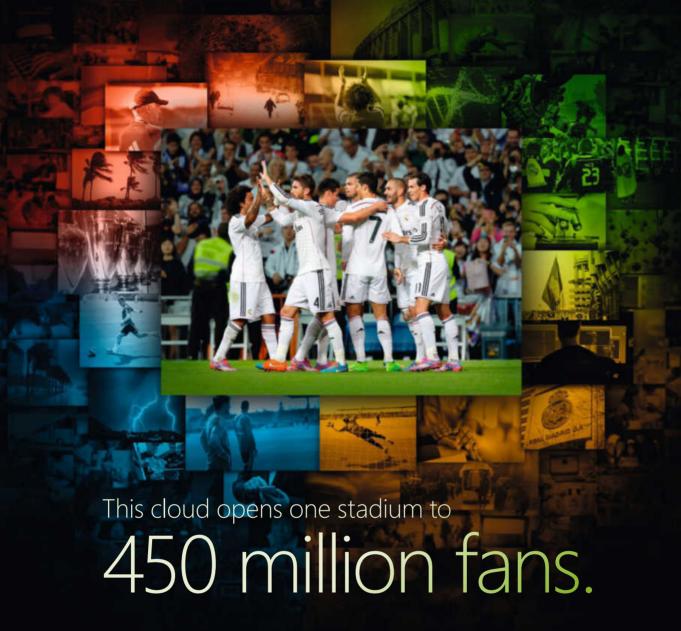
The LinkedIn co-founder writes in the Business section that, in 2016, an education social network will go mainstream: "Education networks make physical classrooms both more intra-connected and more extensible." he says.



DAVID DORAN

"I used pen-and-ink line drawing, printed textures and computer manipulation," says Doran, who illustrates the Government section. "The wobbly lines make the images feel human, though

the subject may not be."



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FROM THE EDITOR

Introducing the best and most radical new ideas for the year ahead

By David Rowan

coming year. WIRED is a publication built on telling stories about innovation in every sector, from tech to design – so in these idea-rich pages you will discover our experts' views on the trends, products, businesses, people and issues that will be significant over the next year. We look at the world through data, with facts rather than opinion as our guiding star, so you will not find any futurology here, nor any provocative if uninformed guesses. Instead, we've leveraged our community of informed,

connected influencers to tell us what they're already seeing – and that the rest of us will soon need to know about.

WELCOME TO WIRED'S ANNUAL GUIDE TO THE

And what an amazing community that is. As well as the WIRED editorial team. vou will read contributions here from Melinda Gates and Yves Béhar, from Alain de Botton and Natalie Massenet. You will learn what matters about virtual reality and the blockchain; about the return of beauty and artificial emotional intelligence. We explain how Netflix and Amazon will boost independent film-making: how algorithms will transform gaming worlds; how drones will deliver ever more supplies; and how robotic swarms will conduct wars. Read Rory Sutherland on relational capital and Reid Hoffman, the LinkedIn founder, on why it will be the year of educational social networks. From connected retail to the US elections, we've covered the issues that we think you need to know about.

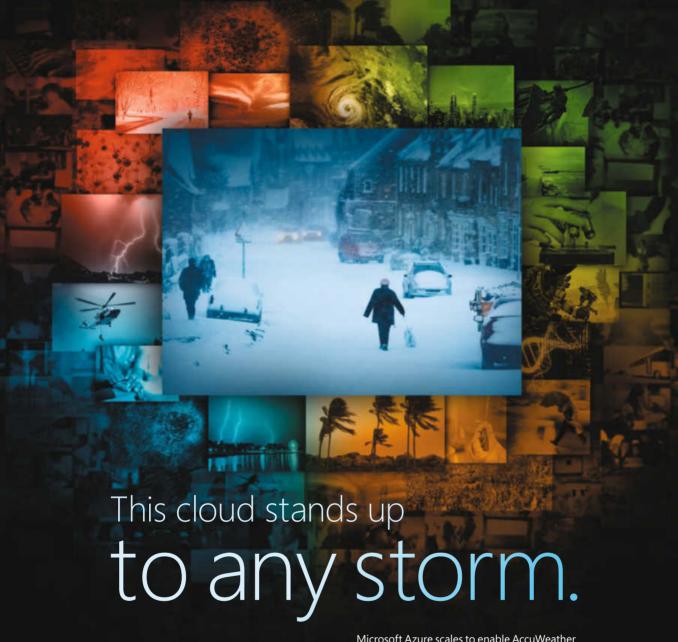
We asked each contributor to tell us what specific changes they see on the horizon

that will affect our readers' lives, not just in 2016, but in the decades to come. "We rethought our approach this year to give the magazine a more utilitarian feel," says Greg Williams, WIRED deputy editor, who is also responsible for this annual publication. "I hope that readers will carry it around for many months, dipping into the content both when they have time to read at home, but also when they're on the road. The breadth and depth of our coverage will make it a powerful resource over the coming months: nothing would please me more than to walk up an aircraft aisle and see people holding worn copies of *The* WIRED *World in 2016.*"

We're fortunate at WIRED to have some of the world's smartest thinkers writing for us - and also a community of readers who are curious, informed and best placed to push the world forwards. Thank you for being part of this project. We hope the insights herein will prove to be a powerful, future-facing resource that is, above everything, useful.







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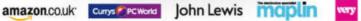


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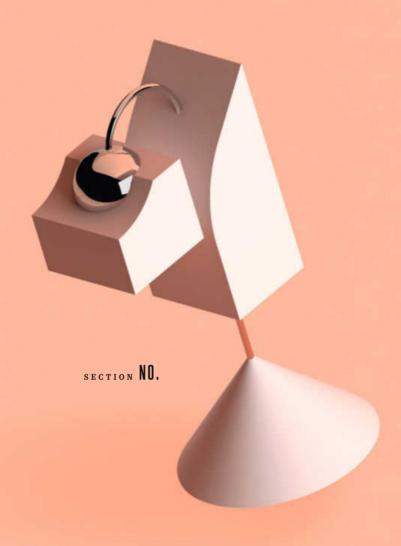








FROM
SENSOR NETWORKS
TO
PORTLESS DEVICES



TECHNOLOGY

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2016: THE YEAR THE SENSOR NETWORK EMERGES FROM COLD STORAGE

The internet of things once meant connected fridges. Now think intelligent street lighting

By Werner Vogels

WE HAVE MOVED BEYOND THE FRIDGE. IN THE

90s when the idea of an internet of things (IoT) was first tabled, we were promised that by the turn of the 21st century we would all have refrigerators connected to the internet in our homes. These would be able to tell us when we needed more milk, eggs or cheese and would automatically order them for us. Despite this promise, we are yet to see our fridges do the shopping. We are now more likely to see the IoT associated with the machine that manufactures our fridge, rather than the fridge itself, with a new trend called the industrial internet of things (IIoT).

The ubiquitous availability of bandwidth, computational capacity and near-infinite amounts of storage at our fingertips through the cloud has been key to driving the IIoT. In the past year, we have started to get a

WERNER VOGELS

is vice president and chief technology officer of Amazon

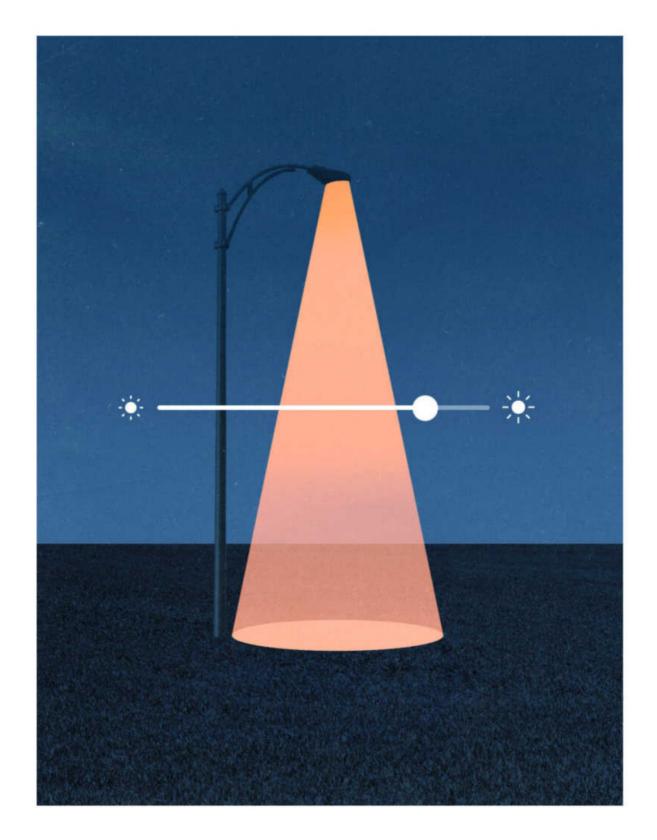


glimpse of what is possible through the pursuit of a more efficient gas turbine, real-time fleet maintenance of trucks and oil and gas. The IIoT is, for me, even more exciting than the connected fridge. It is already changing how we design and interact with machinery and is starting to have a transformative impact on how we live.

Many of the changes brought about by the HoT have been subtle, but we can point to many instances where this trend is changing the world around us. Philips CityTouch is one example. CityTouch is an intelligent light-management system for street lighting. It allows entire suburbs and cities to actively control their streetlights in real time. This allows local councils to keep certain streets well lit to accommodate high foot traffic, turn on lighting during adverse weather when ambient light dims to a dangerous level, or even turn lighting down where there are no people around - in an industrial estate, for example. They are also able to change the colour of lights, which can help direct foot and automobile traffic, for instance, allowing people to follow the green lights so they can safely get from the football stadium to the train station.

This technology has been possible because CityTouch is using the cloud as the back end that runs the system, extracting business value from data collected from sensors installed in the lights. The rise of the IIoT would not be possible without the cloud. Just consider that the UK has more than 5.6 million street lights alone - if each were to produce even a small amount of data each day, it would mean a vast amount of information to process, store and manage. The cloud is able to keep up with this rapid growth and help to create new business models. When a street lamp is not only a source of light but also a thermometer, barometer and traffic sensor, the possibilities for this network of connected devices increases.

Fossil-fuel companies are also using IIoT strategies to manage and gather data from operations in remote, often dangerous,



Intelligent light-management systems will self-adjust depending on usefulness

environments to make better decisions on where to prospect for resources. Shell is using data from sensors in its wells to increase oil and gas output. Each sensor generates about a petabyte of data. Shell is estimated to own more than 10,000 oil wells. Managing and analysing this amount of data would have been unthinkable a few years ago, even to industries such as oil and gas, which are used to dealing with large datasets. Now, with the constant flow of intelligence from the sensors in its wells, combined with increased computer power courtesy of the cloud, Shell is able to change how it operates as an organisation. By collecting these rich data sets, invasive drilling becomes a last option. Researchers and engineers can spend more time on looking for the right oil fields and less time on drilling for resources that may not be there, helping them to save costs and minimise their impact on the environment.

Another sector where we are seeing the rise of IIoT is utilities. The best example of this is the work General Electric is doing. It is one of the world's largest manufacturers of turbines and its products generate 30 per cent of the world's electricity. The company is taking advantage of the IIoT to reinvent itself and, in the process, the economics of the industry. It is also using hundreds of sensors and advanced analytics to make its fleet of gas turbines run more efficiently. General Electric estimates that improving productivity by just one per cent could drive hundreds of billions of dollars in savings.

In manufacturing, the IIoT is delivering real-time conditions on the factory floor, making it possible to not only optimise production and eliminate waste but uncover new business opportunities. Tata Motors, one of the largest manufacturers of commercial vehicles, is putting sensors into its trucks and has built a service model, giving owners of large fleets of trucks a better insight into how their vehicles are running and how they are being used, and to predict and prevent potential breakdowns. The sensors in the trucks can be used to monitor driver behaviour, which can then be used by insurance companies to help set better premiums. This brings new ways of doing business not only to the automotive business, but also to the insurance sector.

These examples are just a glimpse of the IIoT's potential. We will begin to see new

kinds of sensors, with new kinds of workloads, creating a richer IIoT. Video cameras are starting to be used as sensors for IIoT workloads. A video camera is no longer just a simple recording device, but a complex sensor that can monitor a vast number of data points at once. In a vehicle this could be a camera pointed at the wheel taking in data on the wear of the tyres, brake pads and disc rotors while at the same time monitoring the car's wheel alignment, suspension and handling. In the traditional IIoT model this would require a sensor on each of these components, but with the video camera as the sensor, all of this data could be ingested and analysed in near real time to help with the ride of the car or preventative maintenance.

Many innovations in IIoT are yet to be realised and the results of all of this will impact consumers' day-to-day lives in ways we can't imagine, changing our kitchens, cars and homes. Does this mean we will never have connected fridges? I don't think so, but give it a few more years. What we have seen is that the explosion in IoT applications has taken a different path to the one we expected.

The IIoT will change how we design machinery and the systems built on them, from manufacturing plants to airports. As such, we will have a more intimate understanding of these systems to be able to achieve higher reliability and efficiency. These changes will certainly affect how we live and interact with our environment.



SMARTPHONE REARRANGED

-

Alphabet (AKA Google) will pilot test its modular smartphone, Project Ara, in 2016. In the puzzle-like handset, every component from camera to processor - can be replaced individually. They're not alone with this concept, but so far, no one has delivered. GV

ALL CHANGE FOR CHIPS

The semiconductor industry will look for new ways to miniaturise computer chips. IBM is developing "ultradense chips", which have four times the capacity of current chips while being equal in size. IBM's approach is to replace the traditional pure silicon with silicon-germanium, an alloy that requires less power to work at a faster speed. Gian Volpicelli

ARCHAEOLOGY'S FUTURE LIES IN SCANNING THE PAST

In 2016, 3D scanners will be as essential as trowels when it comes to excavating historic sites

By Tom Cheshire

STOPPELAERE HOUSE IS A DOMED DESERT

refuge, built in 1950 for an archaeologist who was excavating and documenting the Valley of the Kings in Luxor, Egypt. Today, it is a 3D-scanning and training centre staffed by Alia Ismail, a 24-year-old Egyptian architect. For eight months, Ismail learned everything you can learn about 3D scanning from Factum Arte, a team of digital conservators, in Madrid: building scanners, programming and running them – and fixing the devices when they inevitably break down in the desert heat.

Ismail will document in fine detail the tomb of Seti 1, the pharaoh who was the father of Rameses the Great. But she'll also be teaching local volunteers how to do the same for other important sites. "The goal is 1,000 people taking 1,000 photos every day," says Adam Lowe, the director of Factum Arte. "We're training local young girls, who happen to be very tech savvy. The idea is you record vast amounts of cultural heritage. You

TOM CHESHIRE

is technology correspondent for Sky News and author of *The* Explorer Gene



have to be proactive and lay the grounds to record the data that's at risk, and do it fast."

We have swapped physical artefacts for their digital signifiers in almost every realm of our lives: MP3s for etched vinyl, text docs for printed pages, YouTube for celluloid, smartphone galleries for printed photographs. This trend will take another significant step in 2016, when the physical world itself will become increasingly digitised and accessible, thanks to low cost laser scanners and innovative photographic techniques.

Recent events means that there is an added urgency: when Lowe mentions data that is at risk, he's referring to valuable cultural sites and artefacts which are threatened both by mass tourism and, more vividly, the nihilist iconoclasm of so-called Islamic State, which has laid waste to historical landmarks including Palmyra and Hatra. Robert Bewley created the Endangered Archaeology in the Middle East and North Africa project at Oxford University; it mainly uses satellite imagery to document sites. "It is recording what was there before, what's there now and what's lost," Bewley says. His team is building a publicly accessible database to track all these



changes, so that even if a site is destroyed, archaeologists can still study its digital ghost. Similarly, ScanLAB, a London-based studio, specialises in large-scale 3D scanning; they capture forgotten, often underground worlds, then make them digitally explorable.

Frédéric Kaplan, a professor in the digital humanities laboratory at the École Polytechnique Fédérale de Lausanne, is using another scanning technology – book readers – to digitise the archives of renaissance Venice, from tax records and death certificates to maps and urban planning designs. The Venice Time Machine project will use this data to create a 3D world that also includes a quasi-Facebook of relationships laid on top. Moorea, a tiny landmass in the Pacific, is part of an ambitious plan to model an entire ecosystem, a digital avatar of the island; 3D scanning is mapping its coral reefs.

Conservation is a natural starting point for these techniques, but they're bleeding more and more into the mainstream, thanks to the growing popularity of amateur 3D printing. In mid-2014, HP started selling its Sprout computer in the UK: a desktop that comes with a 3D scanner built in - or rather, perched awkwardly on top. The device is bulky, expensive and doesn't work especially well. But webcams were in a similar place in the 90s: now, they are a tiny and efficient essential, found in every smartphone in the world. Intel's RealSense technology already looks indistinguishable from an in-built webcam on a laptop: it promises to "make 3D scanning a reality right from your device, so you can scan and save a piece of art, a flower, a toy - even your own face", and that the technology will roll out to phones and tablets. Acer demonstrated a laptop with Intel's camera at CES 2015. Hardware startups Faro and Scanify already offer handheld, easy-to-use 3D scanning devices. More ambitiously, Google's Project Tango, currently available in the US as a developer's kit, aims to turn every mobile device into a 3D scanner, with a combination of advanced computer vision, image processing and special vision sensors.

With the advent of consumer virtual reality devices in the first quarter of 2016, these digital worlds will be fully explorable. Palmer Luckey, the inventor of Oculus Rift, has described VR as a metaverse, "a parallel digital world that exists alongside our own". That digital world will also be our very own one.



HYPERLOOP RIVALRY

Elon Musk's Hyperloop may still be on the drawing board, but California firm Hyperloop Transportation Technology (not affiliated with Musk) claims it will have an 8km-long test segment of its own in 2016, along the Interstate 5 Highway, GV



THE FUTURE OF WEARABLES IS SMART FABRICS, NOT DEVICES

Google and Apple both got it wrong – wearable technology is about more than wristbands and headsets

By Imran Amed

IN SEPTEMBER 2012, MODELS AT THE DIANE VON

Furstenberg fashion show strutted on to the catwalk wearing decidedly unfashionable, dorky-looking glasses with cameras fitted into the frames. It was the surprise debut of Google Glass at New York Fashion Week, and it created plenty of buzz on technology and fashion blogs, but ultimately failed to take off with the consumer. For a while, Glass was sold on e-commerce site Net-a-Porter, but in early 2015 sales were halted as Google took the project back to the drawing board.

Google is not the only technology company that has tried to woo the fashion elite. In September 2014, fashion insiders from around the world were invited to attend Apple's keynote introducing the Apple Watch, followed by a splashy dinner in Paris a few weeks later. Six months on from the

big reveal, as the Watch became available to consumers, 12-page advertising spreads ran in American Vogue and high-profile people in the industry – from Dior creative director Raf Simons to US Vogue editor-in-chief Anna Wintour – could be seen wearing the Watch.

But, soon afterwards, some fashionistas fell out of love with it. In a much-discussed critique in The New York Times, writer Vanessa Friedman proclaimed: "Why I'm Breaking Up with the Apple Watch", listing the reasons why she was sending the device back to Apple. "No matter how attractive the Apple Watch is in the context of other smartwatches or smartbands," she wrote, "no matter how much of an aesthetic advance its rounded corners and rectangular display, it still looks like a gadget."

Apple and Google weren't alone in jumping on the wearables bandwagon. High-end brands such as Tory Burch and the cool kids at Opening Ceremony made forays into the smartband market in 2015. The buzz, however, has faded—the devices either didn't provide any meaningful functionality or they were so unattractive that people simply didn't want to wear them.

Does this mean the love affair between fashion and technology is over? Decidedly not. Wearable devices will be key to so-called "ubiquitous computing". And, as technology continues to advance in areas such as material science and nanotech, the real opportunity may be in so-called smart fabrics.

According to Gartner, whereas smartbands and watches represent a significant portion of the market for wearable technology (see health trackers such as Fitbit and multi-functional watches like the Apple Watch), the largest and fastest growing category is expected to be smart garments, which are predicted to grow from 100,000 units shipped in 2014 to 26 million units shipped in 2016.

"Everyone is exploring wearable tech watches and headbands and looking at cool sneakers," David Lauren, Ralph Lauren's executive vice president for advertising, marketing and corporate communications told *The New York Times*. "We skipped to what we thought was new, which is apparel." The company unveiled technology-enabled tennis shirts, which monitored the heart rate, breathing and stress on ball boys and girls, at the US Open Tennis Championships in 2014.

"Clothing should be our partner in getting through life," said Amanda Parkes of hybrid

SPACE STATION EXPANSION

China will launch its second Space laboratory, Tiangong-2, in 2016. The 14m-long craft will replace the current orbiting lab Tiangong-1, launched in 2012. Tiangong-2 is the second stage of a three-step modular space station to be completed by 2022, when the base station Tiangong-3 is expected to be launched. GV

fashion-tech company Manufacture New York, to *The Business of Fashion* in November 2014. "It's up to us to define how we tap into the many modalities of the body through clothing as the interface to help us navigate the world, communicate, entertain or generally bring us greater understanding of ourselves. Wearable technology does not have to involve traditional circuits and batteries."

This approach – making the technology invisible by shrinking it and embedding into the garment itself – is also being extended to high fashion by designers such as Iris van Herpen, who operates at fashion's avant-garde. Van Herpen's autumn/winter 2015 ready-to-wear collection didn't focus on using technology for functional purposes, but rather on using technology-infused materials such as hand-burnished, translucent meta-weaves of stainless steel and silk to carve out an altogether new aesthetic territory.

This distinction is key. As soon as creation of wearable technology in fashion moves away from the gadget approach that has failed to resonate with consumers, it will enable the product to focus on aesthetic considerations, which are paramount in decisions about what people would like to wear.

Indeed, Google isn't giving up on wearable technology either. The technology giant is teaming up with Levi's on Project Jacquard, a fabric made up of yarns that can interact and communicate with smartphones and other personal digital devices.

How the smart-fabrics space will develop remains to be seen, but it's clear that the current focus on wearable gadgets is limiting the potential integration of fashion and technology.



-

is founder and editor of The Business of Fashion



THE OCULUS RIFT FINALLY DELIVERS ON SEAMLESS VR FOR ALL OCCASIONS

It's been promised for years
- but Palmer Luckey's immersive
device will go on sale in 2016

By Gian Volpicelli



HUMAN VS HACKBOT

-

The US Defense Advanced Research Projects Agency is holding a competition to see if machines hack better than humans, Started in June 2015, the Cyber Grand Challenge will eventually award \$2 million to the team with the most effective software. GV

PALMER LUCKEY STARTED BUILDING VIRTUAL

reality headsets in his parents' garage when he was only 17. Back then, it was hard for the now 23-year-old to imagine that his brainchild, Oculus Rift, would be the most anticipated device of 2016. A gamer and long-time tinkerer, Luckey first announced his project - VR goggles with a 90° field of vision that he named "Prototype 1" - on 3D gaming website Meant To Be Seen in November 2010. Over the next two years, Luckey kept tweaking his creation, in the process becoming a minor celebrity on VR forums. Then, in 2012, he encountered John Carmack, the founder of gaming company id Software. Carmack fell in love with Luckey's sixth prototype - the Rift - and brought it to the E3 video game show in Los Angeles, where it was an instant hit. The device offered a completely immersive 3D-gaming experience for a relatively low price, potentially bringing VR to the centre of gameplay.

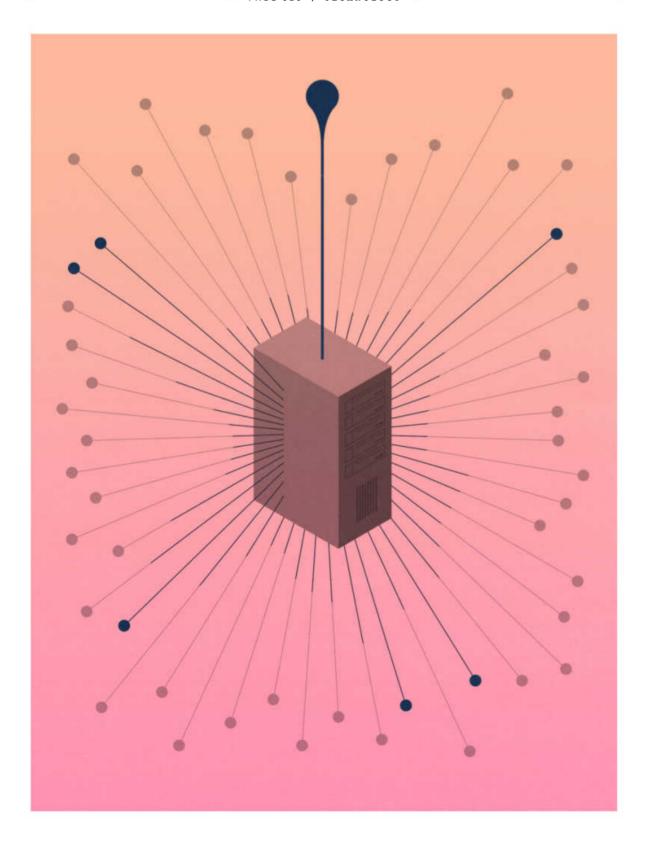
Following this, Luckey teamed up with other gaming entrepreneurs to establish his company, Oculus VR Inc. Shortly after its debut, the company raked in over \$2.4 million (£1.5m) from a Kickstarter campaign promising a Rift kit to anyone who pledged at least \$300. Money also flowed in from bigger investors: a \$16 million round led by two Boston-based VC companies was completed in mid-2013; in December of

the same year, after Oculus's announcement that Rift would use movement-tracking technology to remove motion-sickness - until then, an unsolved issue for VR devices - VC firm Andreessen Horowitz led a \$75 million round. Finally, in March 2014, Facebook purchased the company for \$2 billion. Reportedly, Luckey was sceptical of Mark Zuckerberg's interest - the Facebook founder isn't regarded as a gaming expert. But the deal with the social network has freed Oculus from funding worries, and put the Rift itself in perspective: Zuckerberg can see VR has enormous potential beyond gaming - cinema, education and teleconferencing, not to mention 360° videos on Facebook Timelines, announced at E3 2015.

Oculus is becoming a household name – astonishing for a company that has yet to release its first consumer product. But that will change. The device – available in the first quarter of 2016 – is expected to cost around \$350 and will work in conjunction with Windows 10 PCs and an Xbox One controller. (The company is also developing its own Oculus Touch controls – a pair of hand-held analogue sticks with haptic feedback.) Despite the rising profile, Luckey himself remains as elusive as ever, with no sign of changing: he still lives in a house with six roommates, and flip-flops remain his footwear of choice.



PHOTOGRAPHY: DAN WINTERS



TIME TO GET REAL: MASSIVELY COMPLEX ONLINE WORLDS TRANSCEND GAMING

FOR ALL THE LEGIONS OF PROGRAMMERS

coding the movement of individual blades of grass, and all the advances in processing power and VR, the simulated worlds of online gaming still behave nothing like the real one. It's not just the proliferation of enchanted objects and implausible weaponry. It's something more fundamental. "Say I drop an object on the floor. I leave the room and come back. In 99 per cent off MMOs [massively multiplayer online games], it's just vanished without explanation," says Herman Narula, founder and CEO of London-based virtual-world-simulation startup Improbable. "How can I tell a story? How can I do anything meaningful in a world like that?"

Founded in 2012, Improbable's mission to create a platform upon which developers can build vastly more complex worlds, sprung from Narula's frustration at running up against the limitations of online games. "We read books and we cry, we laugh, we're horrified, we fall in love – those experiences matter to people. Online worlds need to evoke the same thing," he says. "In the last few years we've seen the abysmal failure of games attempting to mimic the *World of Warcraft* model of repeating scripted content. The average gamer age is 37, the industry is worth a hundred billion dollars, and people are hungry for deeper experiences. They want their actions to make a difference."

For that you need something more than a player-centric illusion. You need a world with a complex system of physical laws that allows a person's actions to have significant, lasting consequences. An environment where, if a mine explosion occurs in one area, players in a town far downstream will see debris floating in their part of the river. In turn, the ruins will rust and decay even when no player is present. A world in which if you kill a dragon, it stays dead, rather than re-incarnating for the next player. A world, in short, where things stay where you put them.

This is what Improbable's technology claims to allow. The key, says Narula, is distribution. The standard online games model is a single Enhanced realism in multiplayer games also means we can simulate the real world more effectively

By Kathryn Nave

server per game, meaning the number of simulated entities and players is fundamentally limited by the capacity of that server. To handle huge numbers of simultaneous players the developer can run multiple versions of their game, each on a separate server, with players divided up between them. "Say you want to make a world in which a thousand people can fight together in real-time in one location," Narula says. "A single server is not going to be able to deal with that. To make it work you end up limiting the game in other ways."

Improbable swaps those separated servers for a scalable swarm of simpler, lightweight machines that co-operate to co-simulate the world, swapping work between them to meet areas of higher demand. "Say there's a huge firefight in one location, maybe 20 workers are involved in simulating that. A millisecond later, that firefight ends, everyone's dead, those machines vanish and that piece of the world is taken over by just one," Narula says. "We're talking about live processes jumping between servers in the middle of a calculation. That's never been done before in this context."

It's a bold claim with an impressive team behind it, including former Google Hangouts SRE engineering manager Sam Kalnins and former general manager of triple A games studio Crytek, Nick Button-Brown, along with software engineers from eBay, Amazon and Goldman Sachs. In March 2015, the founders convinced blue-chip VCs Andreessen Horowitz, an early backer of the Oculus Rift, to invest \$20 million (£13m). The same month, Dean Hall,

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creator of the enormously popular open world survival game *DayZ* announced he was working with Improbable on a project, later revealed as space colonisation game, *Ion*, describing it as "The most exhilarating thing I have ever done."

The first public demonstration will come early in 2016 with the official launch of the first game to be built on the platform; made by London-based Bossa Studios, Worlds Adrift will be a massive multiplayer game in which players work together to construct airships from discovered resources and explore a world of floating islands. "We had the idea for Worlds Adrift long before meeting Improbable, but shelved it as impossible for a team our size," explains Bossa Studio's co-founder and gamerin-chief Henrique Olifiers. "The complexity of even just an ordinary MMO means that what would be a trivial single-player problem becomes exponentially more difficult. You need at least a hundred people to pull that off." Yet within just two months of picking up Improbable's platform, Bossa's 30-person team had a beta not just for a standard MMO, but one that showed signs of realising Improbable's claims of complex physics and radical persistence.

"Every activity, whether its chopping down a tree or digging a hole, is unpredictable because these all involve multiple individual entities subject to complex laws, just as in the real world," Olifiers says. "Even if you perform the same action the consequences can be different, and players can create different ways to go about any one challenge." This means that rather than gameplay being dependent on various scripted missions and events, the situations players encounter emerge from the interactions of other players and the world's inbuilt laws.

Much of this has, to some extent, been done before. But a game that can handle both the complex physics of innumerable simulated entities and the demands of thousands of players, all in real time, is something new. Perhaps the closest example, Narula suggests, is the space-exploration game EVE Online - a title in which the results of emergent gameplay extend to complex business alliances, high-level corporate espionage and, last year, a 4,000player firefight resulting in more than \$300,000 worth of collective damage to 75 spaceships. Yet, unlike in the Improbable vision, the persistent wreckage of this almighty battle had to be hand-designed by *EVE*'s developers and inserted into the game days later.

CHILD CONTROL

-

Kids will be able to play on-screen games and exercise outside at the same time, if Hybrid Play's system achieves its \$160,000 Indiegogo target. Its device – which uses accelerometers, gyroscopes and IR sensors – wirelessly links to a child's smartphone to turn swings, slides and see-saws into games controllers. GV



DRONES IN CHARGE

-Bas

Basketball team the Sacramento Kings are using flying supervisors to have their new stadium ready by October 2016. Drones equipped with University of Illinois' software are monitoring the progress of the building site, and can compare the images against the schedule, automatically detecting delays and inefficiencies - including which human workers are to blame for falling behind. GV

Improbable's software is also drawing interest from those looking to simulate something more realistic than intergalactic warfare. "We're talking to people across defence, economics and biology." Narula says, "Researchers who want to build models of things like the world's fish population, or a mirror of London which updates in real time, allowing you to ask questions such as, 'What if this piece of infrastructure were to shut down?" Researchers including David Pugh at The University of Oxford's Institute for New Economic Thinking are looking to use Improbable's platform to build a model of the UK housing market. "Each household has a huge range of varying characteristics to it: income, wealth, composition. To represent that accurately, you need a massive model with complex agents, which has been a problem," he explains. "Previous platforms just don't scale in the way that Improbable's technology has the potential to."

That scalability could eventually encompass other countries' housing markets and even the operations of the wider financial system, allowing Pugh's team to better understand how mortgages are funded and produce insights that could influence the policy of government agencies. "We imagined this would be a narrow thing that only helped gaming," says Narula. "But we began to realise that it was a much more fundamental solution. It's not just something that online games need, it's a better way of handling all distributed computing.

Disclaimer: WIRED editor David Rowan was an early investor in Improbable and had no involvement in the commissioning or editing of this story.



DEVICES WITH PORTS WILL BE CONSIGNED TO HISTORY

The 2015 MacBook was just the start of a broader trend to remove unsightly - and unnecessary - apertures

By Ben Hammersley

BEN HAMMERSLEY

-

is a contributing editor to WIRED, an author, and a TV broadcaster



HERE'S A PREDICTION: APPLE WILL ENTIRELY PHASE

out sockets in its laptops by 2020. No holes, no plugs, no connections at all. Here's why.

Sockets are terrible. They're ugly, ruining the lines of even the slickest device; they're expensive, adding both component and manufacturing costs; they're restrictive, as a device can't be thinner than the biggest socket. They're also prone to failure. A great deal of the web is made of pages with a variation on the theme: "socket not working". That's expensive for everyone concerned.

There's already an undeniable trend to remove sockets. In May 2015, Apple's redesigned MacBook caused a stir not simply because it is available in tasteful gold, but because it came with just the one port, a USB-C socket that also doubled as the power supply. Just as Apple did when it removed the floppy disk drive from the iMac, the design assumption here was that, well, you don't really need it any more.

It's not that big a stretch. Just as, when it was dropped, the floppy disk was being entirely superseded by the CD-ROM and the USB flash

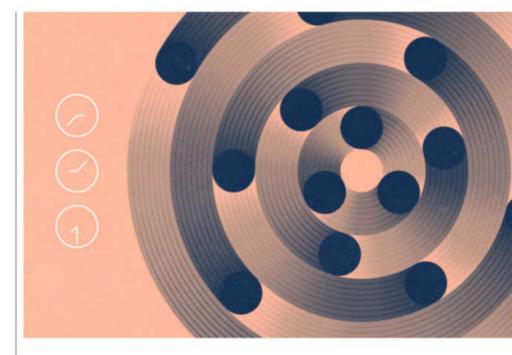
drive, today's cable-based connections are being rapidly replaced by the network. Consider the iPhone or iPad. With all of the iCloud services turned on, there's practically no reason to plug either into a larger machine. Yes, the external drives and tablets beloved of this magazine's art department are going to need a machine that will support them, but for the rest of us? With Wi-Fi, Bluetooth, and other wireless options, most of your laptop's sockets are used to charge other things: your biggest device wet-nursing all of your little ones.

Power is important, it's true. But that 2015 MacBook's advertising spiel has a telling line. "As long as we were going to include a port for charging the new MacBook," it says on apple.com, "we wanted to make sure it was the most advanced and versatile one available."

Fair enough, but consider the first clause: As long as we're going to include a port for charging. As of now, it's no longer necessary. Socket-less charging is already here: the Apple Watch has it, many Android phones have it, even Starbucks offers it in many of its cafés. Using magnetic induction, the power supply simply needs to be in the vicinity of the device you need to charge. Not inserted, but simply alongside. If the iPhone 8, for example, follows the path of the Apple Watch and uses magnetic charging, and ships with Bluetooth headphones, perhaps made by (recently bought by Apple) Beats, then it doesn't need any external ports at all.

There's a transition phase, of course. In early 2015, Philips was the first to demonstrate headphones that connected to an iPhone's Lightning socket – the one you usually use for charging and syncing – ignoring the regular headphone socket entirely. Apart from a digital output for audio, potentially allowing the headphones to do their own digital-to-analogue conversion and hence sounding way better, the Lightning socket can also provide power, which means the new headphones don't need batteries to run, say, noise-cancelling. That power could also be used to drive other features: lights, or health-related sensors, or an amplifier for that extreme bass the kids like.

But in the end, this doesn't solve any of the main problems. It's cool to have available power, yes, but cooler still to have cheaper devices with far fewer problematic parts, with fewer restrictions on minimum thickness, and with a design that finally embraces the networked present. Cut the cord, Apple – it's time to get unwired.





PRINTING WITH LIGHT

California startup
Carbon 3D is
developing a
3D-printing
technique that
uses ultraviolet
light to harden a
liquid polymer into
the desired shape.
The technology
can be up to
100 times faster
than current
printers. **GV**

NEWS JUST IN: THE WORLD WILL BE THE SAME IN 2016

For a true picture of how we're progressing, we need to consider nature's pace layers

By Russell Davies

HUMANS HAVE EVOLVED TO PAY ATTENTION TO

things that move fast. We're good at noticing an attacking tiger, bad at noticing climate change. That's why we have "news" and not "unchanged". And that's why WIRED is packed with things moving fast. It's what makes it brilliant: all the change and disruption.

But we'd be remiss if we didn't also point out that a key defining characteristic of 2016 will be that, for the most part, it'll be exactly the same as 2015. And very like 2014. And much the same as 2006. And, actually, not that different

RUSSELL DAVIES

is a contributing





to 1996, 1986 and 1976. Get a bit further back and it'll get different, but it's important to consider this point: most things, certainly most big things, don't change very fast. It's just that we don't pay attention to them.

For instance, the world in 2016 will still depend on fossil fuels. Transport in our major cities won't move any faster than it did 100 years ago. The best way to save lives will still be to vaccinate people and get more of them clean water. The fashion business will still exist; so will movies, music and advertising. No one working in any of those industries will have any idea how to guarantee a hit. Sub-Saharan Africa will still lead the world in mobile finances, the US and the UK will still have lousy broadband. The Russian secret services will remain convinced that typewriters are more secure than computers. The best way to improve education will be to recruit better teachers. The way to improve the performance of a team will still be to increase the percentage of women. The most effective advances in healthcare will still come from everyone washing their hands properly. And there will still be no reliable way to determine which way to insert a USB stick.

Why spoil this prediction-fest with curmudgeonly talk of nothing changing? Because in order to understand a prediction you have to understand its context. The architect Eero Saarinen put it best: "Always design a thing by considering it in its next larger context – a chair in a room, a room in a house, a house in an environment, an environment in a city plan." The same applies to change and to time. Just as so many apps seem to make sense only if you live in San Francisco – and they fail because most of us don't – similarly, so many prognostications are useful only if you recognise that they're just tiny blips in a larger picture.

For example – you're likely to have read something about a boom in "authenticity", and a return to the artisanal, handcrafted and physical. The recent growth in vinyl record sales might be held up as evidence. You may have seen some graphs starting in around 2005 and going quickly and impressively up and to the right. But then, if you look at the larger, slower context, you'll realise that, whereas the UK bought 1.3 million vinyl LPs last year, it bought 86 million in 1978. The "vinyl revival" represents around one per cent of the market that used to exist.

In his 1999 book *The Clock of the Long Now*, Stewart Brand described his notion of pace layers – a useful way to think about change. Imagine a set of concentric circles, fastermoving things on the outside, slower things at the centre. The surface layer represents fashion and trends, changing all the time. Then, as you move inwards, you get commerce, then slower again, infrastructure and governance, then more glacially, culture and right in the centre, the slow unmoving constant – nature. To truly grok the predictions outlined in these pages you need to consider them in this full-stack of context, because that's the ground in which you'll plant your idea.

Think about Google's self-driving cars, currently self-driving themselves around. They seem to have cracked the technology; those things are probably safer than a human driver, but now they have to deal with long, slow layers of governance and culture. How, for example, does society deal with the fact that real drivers break minor traffic laws all the time – and that it's often necessary to keep traffic moving? Do we want robots doing that? How do we even decide? We don't have good ways for legislation to keep up with technology. That, I can confidently predict, won't change in 2016.

PUSHING THE BOUNDARIES OF (UN)REALITY

The explosion in virtual reality technology has prompted a boom in startups using the format in a diverse and exciting range of work – from preserving historic sites for posterity, to digitising art installations and assisting therapists dealing with phobias. WIRED selects seven 360° content providers we think are worth watching in 2016.

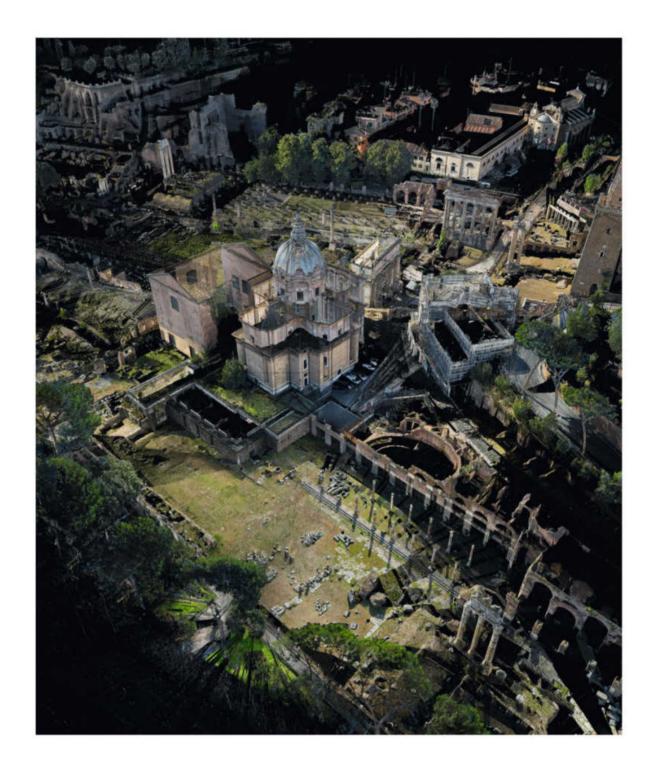
By Liat Clark





THE THIRD FATE

Toronto-based The Third Fate claims it can replicate anything in VR – from cityscapes (such as Manhattan's Columbus Circle, *top*) to temporary exhibits (including Bjarke Ingels's 2014 BIG Maze, at Washington's National Building Museum, *above*). The goal is to capture real-world experiences before they disappear, using high-resolution photography and laser scanning. *thethirdfate.com*



SCANLAB PROJECTS

Founded by two London-based architects, ScanLAB Projects has worked with the BBC, the National Maritime Museum and the Science Museum to capture, then digitise, the minutiae of real-world sites, such as the Forum in Rome (above). Its infrared lasers scan objects 250,000 times a second to produce a 360° photorealistic VR world. scanlabprojects.co.uk







VRSE.WORKS

Founded by immersive artist Chris Milk, with film, TV, theatre and music video producers Patrick Milling Smith and Brian Carmody, and digital artist Aaron Koblin, VRSE.works brings projects to life using a rig of eight custom cameras and binaural microphones. Its short, Clouds Over Sidra (above), made in partnership with the UN, shows the Syrian refugee crisis through the eyes of a young girl. vrse.works





INNERSPACE VR

A French-South-Korean collaboration, Innerspace VR builds cultural and educational narratives that let you explore otherwise inaccessible worlds. *DMZ*, for example (*above*), is a trip into the Korean Demilitarised Zone, as seen through the eyes of a retired soldier. It's all built in CryEngine4, but the plan is to expand the short demos into full productions for Oculus Rift. *innerspacevr.com*





DISCOVR

This Canadian educational startup began life as a university project that was picked up by VR accelerator River. Projects in development include *Discovr Rome* (above), in which you walk round the ancient city, eavesdropping on conversations between its inhabitants. It's a covert way of teaching students, and will be trialled in classrooms in 2016. discovrlearning.com



PSIOUS

Another River accelerator-backed startup, Barcelona-based Psious has developed VR experiences with psychologists to treat fear of flying, needles, spiders, heights (above) and more. All are based on the principles of exposure therapy used by clinicians to manage patients' anxieties, and are designed to be employed by those same therapists as a cheaper, safer alternative. psious.com



VIRTALIS

Virtalis has created virtual reality installations for academic institutions, engineering and healthcare firms for more than two decades. For the German national aeronautics and space research centre, DLR, it created ultra-wide-field simulators for pilot training, such as a cockpit (above) which can portray a photorealistic landscape in a variety of weather conditions. virtalis.com



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FROM MOON MINING TO SMART GRIDS

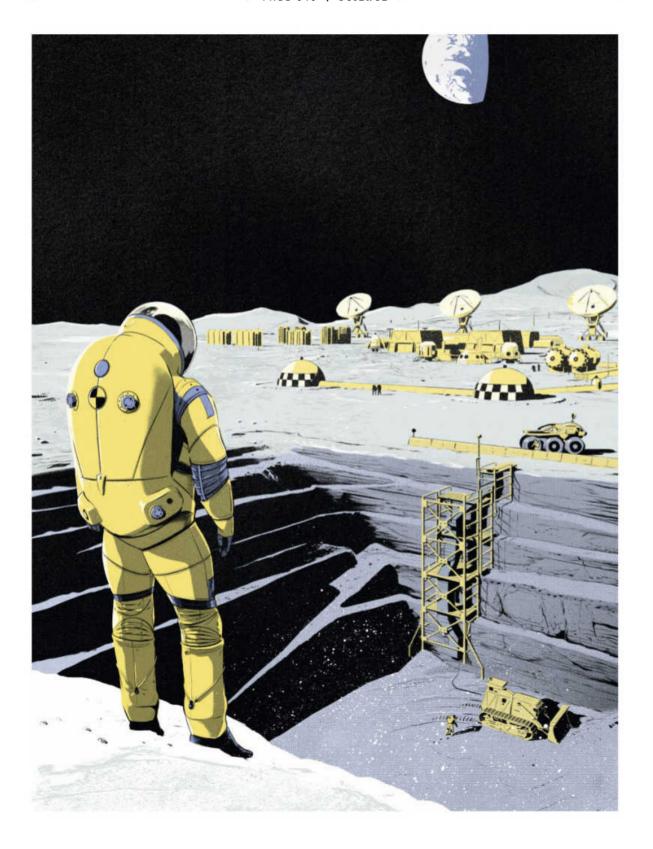


SCIENCE

FEATURING WRITING BY
KATHRYN NAVE
JOÃO MEDEIROS
CHARLIE BURTON

ILLUSTRATION: SEÑOR SALME

SPOT ILLUSTRATION:



MOON MINING TAKES A GIANT LEAP

Plentiful resources of precious metals – and water – will make off-planet prospecting viable

By Kathryn Nave

KATHRYN NAVE

is a regular
WIRED
contributor



MOST OF US SEE THE MOON AS JUST A SMALL

circle in the sky. Naveen Jain, co-founder and chairman of space-mining startup Moon Express, sees quadrillions of dollars worth of valuable minerals, more than a million tonnes of fusion fuel and some prime business estate – and he wants to own it. "So many resources which are extremely rare on Earth are abundant on the Moon," Jain says. "We shouldn't only be mining the Earth, we should be thinking of the Moon as our eighth continent."

Last December, Moon Express became the first private company to successfully build and test a Moon-capable robotic lander – the MX-1 – here on Earth. By 2016, it plans to land on the Moon itself in a bid to claim the \$20 million (£13m) Google Lunar XPRIZE for the first private lander to successfully travel 500 metres along the surface and transmit high-definition imagery back home. In October, in partnership with Nasa, it was on track to launch a shuttle to retrieve experiments from the International Space Station. "On return it will land with ten-metre accuracy," Jain says. "You could land it in your backyard. This is the same kind of system we can use to bring back cargo from the Moon."

Cargo such as helium-3, an ideal candidate fuel for nuclear fusion. Formed in the Sun

and carried through space on solar winds, helium-3 is extremely rare on Earth, thanks to the protection of the planet's magnetic field. The Moon, however, has no such shield and is estimated to have absorbed enough helium-3 to meet global energy demand for more than a millennia. "We know it's there in tremendous quantities, from all the surveys and lunar meteorite analyses of the past 50 years," Jain says. "Even a relatively small quantity could power this planet for generations."

Others are already looking further afield. Virginia-based Deep Space Industries and Washington-based Planetary Resources have both set their sights on near-Earth asteroids, the original source of much of the Earth and Moon's precious metals. "Space travel isn't about distance," explains Planetary Resources' president and chief engineer, Chris Lewicki, who was also former flight director for Nasa's twin Mars Rover missions, "Everything is measured in terms of the amount of rocket fuel that you need. Asteroids have no gravity, so going there and bringing stuff back requires as little fuel as docking with a space station. There are almost 4,000 asteroids that we know of which are energetically closer to us than the surface of the Moon."

In June 2013, Planetary Resources, whose investors include Google co-founder and CEO Larry Page and Virgin Group founder Richard Branson, launched a Kickstarter, raising \$1.5 million towards the funding of their first asteroid-prospecting craft. The 22cm ARKYD optical telescope is set for launch into Earth orbit by the end of 2016. Because asteroids are mostly the same material throughout, analysis of ARKYD imagery will give the company indication of which ones would make promising candidates for mining, Lewicki explains. "We can use optical spectra and the light reflected off these asteroids to tell the difference between metallic asteroids, carbonaceous asteroids with water, and those that are just boring rock."

As with the Moon, a major draw to asteroid mining is the abundance of rare Earth metals found throughout space – in particular, the platinum group, used not only in jewellery but in the manufacture of everything from catalytic converters and smartphones to cancer treatments. Access to an abundance of these, Lewicki suggests, could have a similar impact on technological development as the discovery of how to extract aluminium from the Earth's crust.





TRACKING THE WILD

As sensors become more accurate, and miniaturisation and solar-powered batteries increase their lifetime. scientists will be able to gather a steady flow of data on ecology, evolution and the environment by tracking animals Researchers from the Panamabased Automated Radio-Telemetry System project use monkeys, ocelots and bees to glean data from the tropical forest. In theory, every animal could become a living sensor. Gian Volipcelli

Yet the high value of the most important in-space resources comes not from their rarity on Earth, but from their presence off it – specifically outside of the planet's gravitational field.

"The first resource we're interested in is plain old water," explains Lewicki. "In space, it's never quite where you need it. At the moment it costs us about £60 million per tonne just to get it out there." On the Moon, she says, water will provide the oxygen needed to begin the expansion of human habitation into space. Its presence throughout the universe will essentially fuel its exploration. "The water molecule H₂O contains the elements of the same rocket fuel that powered all 135 space shuttle launches," explains Lewicki. "By capturing water from asteroids and bringing it back to Earth orbit, we'll be able to refuel all the abandoned satellites in space today. And we can serve as refuelling stations around the Solar System for wherever human beings want to take their activities."

Not only fuel stations, but factories. Iron, nickel and cobalt, the base metals needed for spacecraft manufacture, are also abundant throughout space, where zero or low gravity will allow for the creation of entirely new chemical compounds and alloys that would be impossible under the Earth's pull. "There are pharmaceutical drugs, for example, that could only be developed in space," Jain says. "The chemicals will crystallise very differently in something like Moon gravity."

Future spacecraft, 3D-printed with in-space resources, will never need to undergo the violent forces needed to escape planetary gravity, allowing for constructions of currently inconceivable size and delicacy. "This is

going to create the spacecraft envisioned by science fiction," Lewicki says. "Engineers will be working with an entirely different set of constraints than they have today."

Given that humanity first landed on the Moon 47 years ago, why is the exploitation of space's bountiful resources only just getting started? The answer, according to Jain, comes down to increasingly powerful off-the-shelf technologies, making space a much more appealing investment proposition to private enterprise. "Four years ago, the LiDAR used to measure our location and descent would have cost us \$1.5 million; three months ago we bought it for \$1,500. Space-certified cameras used to cost hundreds of thousands. We're using modified GoPros," he says. "Earlier missions to the Moon cost billions of dollars. Now we're able to do that for \$50 million. and costs will continue to come down."

So when can we expect the first space platinum back here on Earth? "We should be bringing back lunar samples in the second or third mission," says Jain, who estimates a further eight to ten years till the establishment of the first producing Moon mine. Planetary Resources is aiming to send a propulsionenabled telescope to conduct closer examination of promising asteroid candidates by 2018. If these are of the right kind, containing water or useful metals, then the first extraction and sample return is targeted for the early 2020s. "We often over-predict what will happen in a year's time, but we almost always under-predict what will happen in ten years," Lewicki says. "Most people are thinking 50 years out, but if they have kids in school today, it's quite possible that their first job could be in space mining."

FUSION POWER

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American defence company Lockheed
Martin will begin work on a prototype of
a compact nuclear fusion reactor
the size of a jet engine. So far, nuclear
fusion is not commercially viable – it
requires more energy than it yields – but
Lockheed Martin is confident it will have
a fully working model in a decade. GV

DNA ANALYSIS WILL BUILD AN INTERNET OF LIVING THINGS

By reading - and sharing - the genetic data in your bloodstream, you'll be able to predict illness

By João Medeiros

WHEN CELLS DIE IN OUR BODY, THEY BURST,

shedding DNA, which ends up in our blood flow. Cells can die for many reasons: from a natural process of aging, as a result of disease or even organ death. They also die at every stage in life. Even as a foetus grows, the continuous death of its cells means that its DNA is transferred through the placenta into the blood of the mother. A mother's blood has about ten full foetal genomes per millilitre, which means that a foetus's DNA can be completely sequenced while still in the womb.

The same process happens with cancer. Cancer cells, due to their fast growth, die quickly, constantly shedding their DNA into the bloodstream, even at an early stage of the disease. Detecting cancerous DNA would enable much earlier detection.

Recently, Dennis Lo, a chemical pathologist at the Chinese University of Hong Kong who invented the maternal blood-DNA test, performed a cancer biopsy while tracking the tumour's DNA concentration in the patient's blood. Performing blood tests every 15 minutes, his team showed that as the tumour was removed, levels of its DNA in the blood dropped.

"If you take a patient's sample of blood, you can find the tumour DNA," says Clive Brown, CTO of biotech company Oxford Nanopore. "If part of the tumour is missed, you can still spot its DNA in the blood, so you can know if the surgery has been successful or not."

Lo couldn't track the DNA concentration in real-time, but in 2016, we will be able to use portable sequencers such as Oxford Nanopore's MinION, a USB-stick device that uses nanopore technology to sequence DNA on the spot.

"DNA changes all the time," Brown says. "If you drink alcohol, your liver cells start to die – they shed DNA and your gene expression

JOÃO MEDEIROS

is WIRED's science editor, and editor of our R&D section



changes. If you get infections or a virus, you'll have that DNA in the blood. If you think of your blood as like a sewer, everything is in it – and it's dynamic. There's a lot of stuff in there that's irrelevant, but you can measure a baseline and then, one day, something changes – some new things appear that aren't there normally."

MinIONs are already being used in a variety of ways, from tracing illegally traded timber to Ebola sequencing. The next step, according to Brown, is to connect all the genetic information to the internet. In 2013, Oxford Nanopore founded a spin-off company called Metrichor, which provides cloud-based analysis of its users' biological data, in real time. The goal is not only to help individuals, but to spot trends aggregated from thousands of users, a concept that Brown calls the internet of living things. "With companies such as 23andMe, you spit into a tube, send it away, and wait for the results," Brown says. "We're going to replace them. Now you can use your MinION, take a drop of blood and get an inventory of all DNA in your blood. You will be able to spot trends and track your data continuously. Once we get enough people doing that regularly over a long enough period, you can build up an enormous database of real-time data. We'll break the stronghold of doctors and insurance companies when millions of people are sharing this information."



LET'S BE HONEST. NOBODY EXACTLY LOVES THEIR

electricity supplier. The service is impersonal, prices skew high and estimated billing is an antiquated practice in an age when we're producing vast amounts of data. Sure, energy companies have done much to earn their bad reputations, but it's also true that the system they're dealing with has not evolved in principle since London's Edison Electric Light Station first whirred into action in 1882: power gets pumped from a central point to a large number of users, with delayed feedback about how much is being used or when. It's expensive, it's inefficient and it's fragile.

In 2016, a UK government initiative that's being billed as the biggest national infrastructure project in living memory aims to change all that. Due to complete by 2020, it will furnish 26 million homes in the UK with smart meters. The £11 billion project will be a gateway to a smart grid.

Although the implications of smart meters could prove transformative, the devices themselves are simple. They record energy consumption at regular intervals and send the data back to the supplier. In their simplest application, the meters will be used to show consumers how much power they use. The theory is that once users see the impact of turning on the washing machine or boiling the kettle, they will act more prudently. British Gas, for example, which will undertake installations at nine million households, won't simply present users with a high-level kilowatt-hour figure, but use algorithms to indicate which devices are guzzling the most energy. The company's trials show that these numbers alone cause bills to fall by around two per cent. The full potential of this technology, however, goes well beyond guilt.

As the country gets re-equipped, expect the proliferation of "time of use" tariffs, which vary prices throughout the day. Currently only a crude version, offering cheaper night-time power, is available to a minority of the population. Through smart meters, more sophisticated formulations can be set remotely. These could reflect the underlying costs of local or national energy – if a period of the day is proving particularly demanding, the supplier may levy a premium to use electricity during that period, and discount power at other times. If that sounds like a potential customersatisfaction disaster, British Gas, which trialled a similar idea with 600 users, says that the

SMART GRIDS WILL EMPOWER ENERGY USERS

Generating and storing your own power will make everyone a supplier

By Charlie Burton

utility shared that concern. "But actually, when we spoke to customers, they got it," says Stavros Sachinis, a project manager on the company's smart-grids programme. Peak period power consumption dropped by 9.7 per cent. "If you scale that up across the UK you're talking about 2.5 gigawatts of power stations that you wouldn't have to fire up."

And the expanding internet of things will spur the grid to get smarter. Imagine your washing machine is networked to your smart meter. You could set the cycle to begin only when power is cheap; alternatively - in return for a discount from your energy supplier - you may simply program a deadline for when you need the cycle finished and permit the machine to start automatically when the grid isn't strained. This flexibility will become paramount in a future where electric cars line our streets. "The nightmare for the grid about electric vehicles is they're essentially double the demand of a house," Sachinis says. "So if you have a whole street of cars and their owners all get home from work at exactly the same time and plug them in, you're going to have real problems on the network." Automatically stagger the cars' charging by even a few minutes, though, and that problem's vastly assuaged.

Those vehicles may in fact become a useful component of the grid. They contain capacious batteries so could double up as storage devices, sending power back to the owner's

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DRONES FLY LIKE FLIES

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Scientists will look to insect flight to create more versatile drones. The wings of insects such as bees allow them to fly smoothly through strong turbulence, and to move along irregular flight paths, Scientists at the US Army Research Laboratory in Maryland have built prototypes of tiny bee-like drones with ceramic wings. The goal is to deploy them in crisis scenarios. such as the aftermath of earthquakes or hurricanes, in order to locate people under rubble or inside collapsed buildings. GV

home during peak times. Drivers who own petrol-powered cars may instead opt to buy a home battery, and a number of companies are already working on these including Siemens, Samsung, Mercedes-Benz and Tesla. "Batteries are a key enabler of smart grids," Sachinis says. They will come into their own as houses generate more of their own power through solar cells: charge up the battery during the day, then run the house off it at night.

Still, might consumers not wish to sell this power back to the supplier instead of storing it up? "When you start spilling solar back on to the grid, it's actually not very good for anybody," Sachinis says. "There's this whole 'Export to the grid and get paid', but in fact you're better off if you use it yourself, because you want to offset the higher price you would have paid, rather than receive the lower price you get for export."

Washing machines with a mind of their own, cars powering houses: ideas like these are years from ubiquity. Nevertheless, in the immediate term, a host of innovations will try to give teeth to smart-meter data. Many will draw on

behavioural science. The best-known pioneer in this area is Opower, which shows customers how their energy use compares to others' in similarly sized houses. And there are also set-ups such as CEIVA which, since 2001, has manufactured digital picture frames that connect to the web. In 2011, it created a new smart meter function, interpolating the usual photo stream with consumption stats and energy-saving tips that appear every 90 seconds. The idea was that the photo-frame aspect would make people happy to have it openly on display. "It's the idea of making it glance-able," says Wannie Park, CEIVA's vice president of strategic partnerships. "If you glance at it enough times, you get the information embedded in your day-to-day life."

In the further future, however, such messages might be redundant because the national grid itself may become less important. We could be living in a world where consumers have super-efficient homes and are mainly generating on site. The supplier would merely offer a system for managing the energy. "Then the grid," Sachinis says, "would simply be a backup."





INTELLIGENT WASHING

Why should sharp design and cutting-edge tech be reserved for the rest of the home, but not your laundry room?

The Siemens home appliances range of washing machines spell style from the start. A futuristic TFT or LED display, and a central control dial that glows blue, complement the perfectly round, white-and-chrome porthole door.

It's not just looks these machines benefit from, they perform too. With sensor-controlled technology across the range, these washing machines can analyse your laundry load, automatically dose the correct amount of detergent and adjust the machine's cycle to reduce time, energy and water consumption – controlling every step of the washing process. This is Siemens iSensoric technology at work.

The good news? iSensoric technology is also available across Siemens dishwashing and cooling appliances. Your home is about to get a whole lot smarter.

For more, visit siemens-home.co.uk



Auto-dosing i-Dos is an auto-dosing system. Load with detergent and the machine automatically estimates the required dose.



Stain removal Siemens washing machines adapt each wash to remove common stains. No soaking required.



Guarantee Siemens washing machines are covered by a five-year parts and labour guarantee for peace of mind.



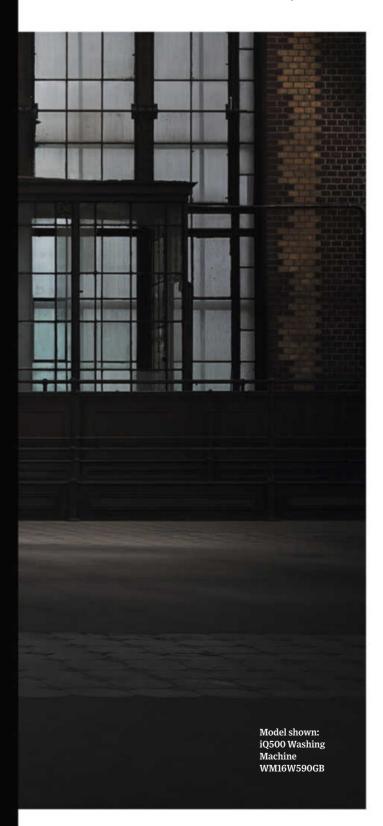
Autoprogrammes These machines use sensors to steer the whole washing process with perfect results every time.



Waterproofing Siemens have added a programme to wash and waterproof at the same time, and recommend using Nikwax.



rapid15
This wash
cycle will clean
clothes in super
swift time.
rapid15 washes,
rinses and spins
laundry in just
15 minutes.



WHY DIGITAL SECURITY SHOULD BE YOUR BIG PRIORITY

At WIRED's two-day event, HP and WIRED co-hosted an early morning panel session to discuss the biggest threat to business



THE PANEL

Greg Williams

Deputy editor,
WIRED

Andrzej Kawalec

Global CTO, enterprise security services, Hewlett-Packard

Rhod Davies

Managed security services chief technologist, enterprise security services, Hewlett-Packard

Tim Grieveson

Chief cyber strategist, enterprise security products, Hewlett-Packard

Sebastian Anthony

Senior editor, Ars Technica UK On the morning of WIRED2015, a VIP group of attendees met for a discussion about one of the most pressing issues of our time – digital security. The government estimates that a fraud or cybercrime is committed in the UK every four seconds. So what can be done to protect our own businesses?

The session, co-hosted by HP and WIRED, sought to answer such questions – and more.

"At HP we believe that every single digital interaction needs to be protected," said Andrzej Kawalec, global CTO for enterprise security services of HP, at the event. "We do that around the world, across ten global security operation centres, with 5.000 security professionals."

Scale is one thing, but being reactive and

nimble in your defence is also critical, says Rhod Davies, managed security services chief technologist, enterprise security services at HP.

"One of the things that's changed in the time that I've been in information security is the stance from believing we can lock it down and leave it to run itself, to having to watch what's going on and be active in response," said Davies.

An active reponse is certainly required today – especially when data breaches can come from within the organisation.

"Insider threats are more difficult to detect, as insiders tend to know more about the systems and processes," says Tim Grieveson, chief cyber strategist for enterprise security products at HP. "And they can hide because they know what we, as security professionals, are looking for."

So what can businesses do today to shoreup their defences? Kawalec suggests companies build a three-part strategy based on five-minute, five-quarter and five-year horizons. This incorporates short-term defence, plus a road map to a long-term security strategy.

Visit wired.co.uk/promotions/hp-security



On November 1, Hewlett-Packard separated into HP Inc. and Hewlett Packard Enterprise

FROM AEI TO BRAIN GAMING



MEDICINE

FEATURING WRITING BY
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Artificial Intelligence (AI) is the science of making clever machines. It's coming along very well. There are already some phenomenally smart boxes out there, including the ATM, your smartphone and the automatic landing system on an Airbus A380. People can do all the tasks these machines perform for us, only much more slowly and very much less reliably.

When people think of how machines will help us in the future, the emphasis naturally falls on the performance of rational executive tasks. But one should also envisage a far more exciting scenario, one in which computational power is also directed at the emotional and psychological dimensions of existence. It is time to imagine not merely AI but also, and even more significantly, what we call AEI: Artificial Emotional Intelligence.

We need AEI rather badly because our emotional frailties dwarf our incapacities in raw mathematics or data management: we make extremely poor decisions about how we should manage relationships. We have little idea what job to focus on and when to quit. We don't know what to spend our money on. We get holidays wrong, have no clue how to repair friendships or handle tricky employees and fumble as to how to reconcile with our parents.

The emotional intelligence required for these things is in very short supply. It exists, but in isolated and mysterious pockets: a few people seem to cope but on a basis that is desperately private and concealed, the way that a wild strawberry might have seemed before the invention of farming.

Of course, at heart, emotionally wise decisions aren't luck at all. They are the result of our brains resolving certain puzzles very well – and they are therefore logically also forms of intelligence that can be replicated and improved upon artificially, with the help of microchips and code.

We are at a juncture in history where we can already perceive what is coming: a particular type of scarcity will start to give way to abundance. A transformation that has occurred many times before in different areas of existence – agriculture, transport and energy – is about to strike the field of emotional intelligence. We're about to make emotional intelligence as common and as cheap as pencils. We're not used to thinking that the next big thing will be tackling the scarcity of wisdom, but this is what's on the cards.

ARTIFICIAL EMOTIONAL INTELLIGENCE WILL PUT OLD HEADS ON SHOULDERS OF ALL AGES

How our decision-making will be improved by microchips and code

By Alain de Botton

ALAIN DE BOTTON

is a philosopher, writer and TV presenter. His most recent book, *The News:* A User's Manual, was published in 2014



Six areas that Artificial Emotional Intelligence will revolutionise:

1. SELF-KNOWLEDGE

Knowing yourself is at the heart of directing efforts successfully – and communicating inner needs and perspectives to others. The idea of self-knowledge has always had high prestige, but the opportunities for acquiring it have been restricted. It's taken too long, been too chancy or too costly (if sought via therapy). The current lead-vehicles for self-knowledge – books – are inefficient, directed at a generic reader rather than you in particular, and carry insights that drain quickly from our minds.

AEI will draw on more reliable information about what is *really* going on inside our brains and will tell us and those we care about who we are, what we are feeling and what we should optimally seek at any point in time.

At present, we are often deeply ignorant about where our talents lie, what our flaws are and what our true interests might be. Our consciousness doesn't grasp at all well what is happening to its owner. For example: I might not realise that the true cause of my irritability is tiredness; I might think it's simply that my partner is being excessively obtuse. But AEI will get us the self-knowledge we need. It will map brain activity and alert us in good time as to the reality of our psychological lives.



Or I might feel that the dullness and anxiety I experience most days could be solved by throwing in my job and going travelling for a year – whereas in fact, the real issue might be bound up with a need to address my relationship with a competitive older brother.

With AEI technology, the work of therapy helping us to understand ourselves – will speed up and be made more reliable and affordable. We will get much better in two areas in particular: knowing what job we should be doing; and knowing whom we should try to form a relationship with, and how.

Today's dating questionnaires and career counselling tests will – from the perspective of 20 years hence – seem as barbaric and hopeless as medieval brain-surgery strikes us now. We will at last be equipped with machines to which we can address not the simple puzzles of our times ("where is the nearest pizza restaurant?"), but also the truly important emotional questions with which we fumble: who should I marry? Is this job in line with my true talents? What should I try to be?

AEI will give us a picture of our inner selves which will prevent us making so many catastrophic errors on the basis of a fatal inability to interpret our own emotional functioning and psychological potential.

2. EDUCATION

Education goes wrong because we're not good at knowing what particular individuals are capable of, what they really need to know, when it's best to try to teach them, and what manner of instruction suits them best.

We all know from our own lives that there are moments when we've made remarkable strides and others where progress has been slow, but our society has yet to arrive at sound generalisations. The idea of how you make a "good" teacher is still shockingly mysterious.

People are therefore funnelled, sheep-like, into classrooms and talked at for hours in ways that serve a lot of them rather poorly. But our educational problems aren't just around schools; throughout life – in relationships, at work, in families – we are always stumbling because of deficiencies in learning. AEI will help us to evolve towards the best versions of ourselves. We should – ideally – die with far fewer regrets.

3. NEWS MEDIA

We're all agreed that high-quality, widely disseminated information is vital to a flourishing society. That's why certain news organisations make huge claims about how well they keep us informed – and what good citizens they help us to be.

But, in truth, news media feed our brains in highly inadequate, sporadic and often manic ways. We do need good information, in the right doses, about the right subjects, to help us lead our lives the way we want to. But we're currently a long way from getting it.

This matters so much because the media set the backdrop to politics: they establish the general picture of what life is like in our society (of which we witness only a tiny portion first hand) and define the parameters of what politicians can change and address. Getting the right information into wide circulation, however, is exceedingly difficult, because our brains are designed to be more engaged by the wildly exceptional (an axe murderer, a celebrity wedding) rather than the important and the sober.

In a future with AEI, we'll know how to lead people to information that is genuinely fruitful for them and their nations, rather than merely click-baiting them with stories that titillate and horrify, but don't manage to change anything in the world other than the bank balances of the evil geniuses at BuzzFeed. We'll get better media and, in turn, more democratic politics.



INFLATABLE MEDICATION

Silicon Valley startup Rani Therapeutics is developing a robotic pill that inflates when it comes into contact with destructive digestive enzymes. Its surface is covered with microscopic needles made of sugar, which in turn inject the drug directly into the patient's intestinal walls. Gian Volpicelli

'INCREASING EMOTIONAL INTELLIGENCE IS THE KEY TO ALL THAT WE MOST VALUE: EMPATHY, CREATIVITY, KINDNESS AND GENEROSITY'

4. ART

Great works of art are, at present, incredibly rare. We are trying hard to "farm" art, but it is not going particularly well. We have costly writing and art schools that start with the best intentions, charge a fortune and are the focus of intense hopes – but they turn out mediocrities by the hundreds.

A Tolstoy, Picasso, Lennon or Louis Kahn are still agonisingly unique. AEI will stop us having to feel so grateful to them. We will, for example, be able to produce novels like those of Tolstoy on an industrial scale, but geared towards our own particular circumstances and cultural references. War and Peace is often appreciated for its wisdom and insight. But the author exercised his mind on understanding the world he knew best: that of wealthy Russians living in the 19th century. As his readers, we are left alone to guess the implications for our own radically different lives.

With AEI to hand, we would be able to direct Tolstoy's emotional genius on the specifics of our own lives. We would be able to summon up a Ugandan Tolstoy or an east London Tolstoy: the same level of maturity and compassion, the same verve in characterisation and storytelling, but all focused on what it's most important for us to dwell on.

5. SHOPPING

Consumer society is really about choice, and in so far as it makes us happy (rather than leads us to squander our wealth and energies), it's about wise choice.

This opens up a huge area for AEI. At the moment, we tend to operate on a mixture of intuition, hope and habit and are routinely abused by advertisers along the way. We have massive frailties in this area: we're heavily influenced by what others are doing (though it might not work for us); impulse plays a big role (though it's not the most reliable guide); and we leave a lot of things to chance (we go for what happens to be most readily available).

AEI will mean encoding consumer intelligence. Just as we might work out a sum in our heads and then check it on a calculator, so we will be able to check our decisions on an AEI device. We can imagine already what would happen with an ideal travel agent, bookstore attendant, gallery tour guide or

personal shopper. AEI will make these figures into daily realities, revealing how we can be persuaded, moved and motivated to acquire goods and services in line with our true needs. Money will, at last, make us as happy as it can.

6. RELATIONSHIPS

It's extremely hard to be wise around relationships. We struggle to communicate, are impatient when we don't get what we want, are defensive in discussions and have trouble talking calmly through our hopes and failings around fidelity.

AEI means we will be able to tap into the lessons that others have, often painfully, learned. Each couple will not have to confront each hurdle anew late at night in the bedroom. If you could, at critical moments, (in your head) dial up your most patient, experienced and sensible friend and get them to talk you through an issue, a huge quantity of distress might be avoided. Relationship AEI will give us all access to the ideal friend's wisdom when we need it.

There are currently some big worries over

AI: what if machines take over that are really versions of very cunning, powerful people? This way of thinking is based - rightly - on our sense of how rational, executive intelligence can be impressive but also horribly brutal: Vladimir Putin is highly intelligent, Goebbels was, in some ways, extremely smart. Massively increasing rationality can be a frightening prospect. But the cure to these fears is to focus on what sort of intelligence AI should really emulate and enhance. Increasing emotional intelligence isn't frightening, it is the key to all that we most value: empathy, creativity, kindness and generosity. We face a race to ensure that we can have adequate levels of maturity and wisdom to counterbalance the enormous increase in our technical prowess. Worries about machines "turning evil" might be more accurately expressed as a fear that they will lack emotional intelligence. This doesn't have to be the case.

Today, the major impediments to progress are all psychological. It's mainly the flaws in our emotional capacities that ruin existence. But we've not yet addressed how to make ourselves more mature. It's been left to the hazards of individual experience. AEI will use technology to reduce the randomness.



DIY BRAIN THERAPY

Researchers from Johns Hopkins University, Maryland, are developing a helmet that would alleviate the symptoms of Parkinson's disease without requiring surgery. The three-pronged headpiece uses electrodes to send low-level currents through the cortex to stimulate the wearer's brain. GV



JOÃO MEDEIROS

is WIRED's science editor. He wrote about the Extreme Memory Tournament in issue 09.15



READY, PLAYER ONE: GAMING WILL HELP TO UNLOCK OUR BRAINS

Digital medicine in the form of video games will soon compete with drugs

By João Medeiros

LAST SUMMER, NEUROSCIENTIST ADAM GAZZALEY

spent two months playing video games. For five days a week, he played *Meditrain* – which involves concentrated meditation and was developed in collaboration with games studio Zynga – on his iPad Air, and another called *Rhythmicity*, which he developed with Mickey Hart, drummer for the Grateful Dead, and Rob Garza of Thievery Corporation. "It's based on the hypothesis that our brain is a rhythmic machine," Gazzaley says. "If we become more rhythmic, we improve coherence between brain areas and see a benefit on cognition."

Gazzaley would also come into his laboratory at the University of California San Francisco at 7.30am three times a week to play *Body Brain Trainer*, a game that trains physical and cognitive fitness using motion capture.

"This project is very different from anything I have ever engaged in before," Gazzaley says. "It is my own exploration of a unique neurological CrossFit programme, or what in the lab we refer to as the Neuroman project. It gives me a unique view of being a participant in one of our studies, the games that I helped design and develop and, of course, an opportunity

for me to see how many of my 46-year-old cognitive, physical and neural metrics I can push to a 20-year-old's level."

To track his progress, Gazzalev used MRI, EEG, stress tests, physical tests (from VO, Max to vertical jump measurements), sleep tracking, saliva and blood analysis. The Neuroman project will not scientifically validate these games, but Gazzaley has ongoing randomised placebocontrolled, double-blinded studies that may. Gazzalev is also the co-founder of Akili Interactive, a Boston-based game company that developed Evo, a game that will soon start being clinically tested as part of the US Food and Drug Administration approval process on a clinical population of ADHD patients. "We need to prove that this game has the same level of clinical efficacy as current pharmaceuticals," Gazzalev says. That's his belief: in 2016, these games will be the first of a new class of fully digital medicine that can help us not only improve our brains but also treat conditions such as depression, traumatic brain injury, ADHD, dementia and autism.

At his Neuroscape laboratory, Gazzaley and his team not only design video games to activate and simulate specific brain networks but they also test them using a variety of measures: eye movement; EEG activity; skin responses; body movement; and heart rate variability. "Brain performance data captured during gameplay is fed back into the game engine, so the game is adapted based on that information," Gazzaley says. "We also can take EEG data to guide transcranial stimulation of the brain.

"For 50 years, we've been trying to come up with drugs that improve cognition," Gazzalev says. "We don't have a single success story." There are various reasons for such failure, he claims: chemical drugs can't target specific areas of the brain; they are not customised to the patient's genes; and they are open-loop, so they don't use feedback to determine if the goal has been achieved. Using video games, Gazzaley is designing a system to improve our brains that is personalised and closed-loop. "For now, you take a pill, subjectively evaluate your own effects, go to the doctor several months later, and he makes a decision on the spot based on no empirical data whatsoever," Gazzaley says. "It's very sloppy."

HUMANS BECOME BIONIC

The next generation of prosthetics will be bespoke, adaptable – even desirable

By João Medeiros

ONTHE EVENING OF MAY 18, 2012, JAMES YOUNG FELL

under a London Docklands Light Railway train at West Silvertown station and was dragged along the track. He was under the train for 30 minutes until a helicopter arrived with a medical emergency team. Young was saved – but his left arm was severed and he lost his lower left leg.

Young, a keen gamer, now plays his favourite video game, *Metal Gear Solid V*, using an artificial limb made in collaboration with Konami (the game's developer) and prosthetic artist Sophie de Oliveira Barata.

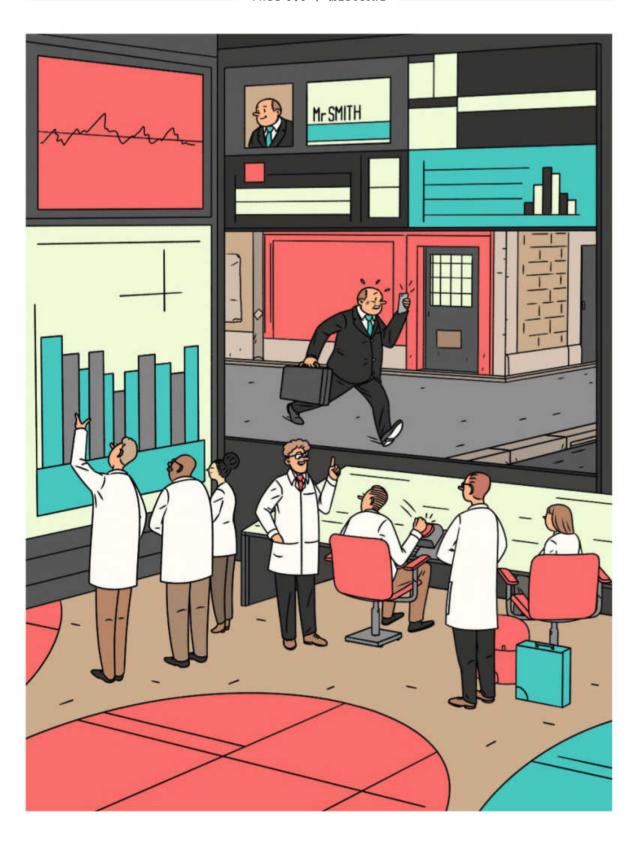
In 2016, prosthetics will not only be more advanced, but also customised to the individual. At the forefront of this trend is Barata. She is known for designing futuristic prosthetics, such as the crystal leg worn by singer Viktoria Modesta during the 2012 Paralympics Opening Ceremony. Young's arm was completed in October 2015. It has secret compartments. which he can use to store pills for his phantom pain and lights that indicate when the arm needs recharging. Young can also pick up objects, give a thumbs-up and shake hands. His artificial hand, which he controls with his back and shoulder muscles, was made with Bristolbased Open Bionics and is programmable, allowing Young to customise his own gestures.



FOCUS ON DIABETES

Canadian startup Medella Health is designing a smart contact lens to help diabetic patients. It would comprise a micromachine that would monitor the user's condition by measuring the level of glucose in their tears. It has received a \$100,000 grant from the Peter Thiel Foundation, GV





WHEN ASSESSING A PATIENT, MEDICS LOOK AT

snapshots of physiological data that are manually taken by doctors or nurses, and make decisions against patient history, family background and test results, as well as their own knowledge and experience. But what if this data was constantly being taken, every second of every day? And what if a system was clever enough to compare these readings to thousands of patients worldwide with a similar history and disorder, as well as all the current clinical guidelines and studies, and make clinical suggestions to doctors?

In 2016, this kind of data-led decisionmaking will come ever closer. Sentrian, a California-based early-stage machine learning and biosensor analytics company for remote patient management, has created a system that does just that, and it's currently being trialled on patients. "We actually don't monitor people very frequently," says Jack Kreindler. Sentrian's founder and chief medical officer. "If I see a patient once a year, I may spend one hour listening to them, and the rest of the year's 8,759 hours not listening to them. We are trying to build a system that will enable us to listen to the lives and bodies of patients all the time, so we can make better, earlier and more personalised decisions."

Currently, wireless biosensors can collect simple data such as body temperature and heart rate as well as more complex information like oxygen saturation of the blood and potassium levels. Remote patient monitoring is typically done with one or two sensors at a time and the data is usually assessed by clinicians. But if a patient could constantly wear several sensors at a time, the amount of data produced would be enormous.

Sentrian's approach collects data streams from biosensors and uses machine learning algorithms to detect subtle patterns based on general information within the system on chronic conditions. These can include heart disease, diabetes and chronic obstructive pulmonary disease (COPD). Data such as heart rate, blood pressure and oxygen saturation from wireless biosensors on the patient are pushed to a cloud-based engine that analyses this data and notifies doctors when needed.

Martin Kohn, chief medical scientist at Sentrian, who practised emergency medicine for 30 years, explains the value in this approach. "It's based on the premise that for

MACHINE LEARNING WILL KEEP US HEALTHY LONGER

Data-crunching supercomputers are on hand to give our doctors all the evidence in the world

 $\mathrm{By}\ \mathbf{Nayanah}\ \mathbf{Siva}$

many patients with diseases such as congestive heart failure and COPD, the processes that lead to severe illness start days before the patient actually becomes acutely ill." he says.

The system is currently being tested in clinical trials in the US and UK in patients with chronic heart failure, COPD, high risk of falls and cancer. Early unpublished evidence has already shown the possibility of being able to spot congestive heart failure exacerbations up to ten days in advance. "That is quite extraordinary - before you maybe only had hours," Kreindler says. "We are seeing subtle, personalised patterns and data where odd things, which we didn't really expect before, may end up having strong statistical significance in predicting whether someone is going to fall over many days in advance." Very early research is showing that, in some people, factors such as heart rate variability, sleep duration and body temperature may be indicators of an impending crisis, These differ from the currently accepted warning signs and evidence-based triggers for treatment.

But are we ready to hand over all decision making to a black box, particularly when it comes to healthcare? "At the moment, there is a barrier, even from the profession themselves, to trust the kind of outputs that machine learning can deliver." Kreindler says. Sentrian has tried to account for this mistrust by giving some control back to humans - for example, by allowing doctors to specify rules for their patients. So, a scenario may run: "If Mr Smith's heart rate rises significantly, but his activity is going down and his breathing rate is going up, send a text message to the patient and a family member. If there is no response from the caregiver or patient after a text message, one email, and one phone call, then make a call to their doctor."

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These rules, which can be general or personalised, are the kind of complex event-processing and subtle pattern-recognition that is going on in an experienced team of clinician's heads when they are monitoring a patient in intensive care, explains Kriendler.

And Sentrian's system will continue to learn exactly which rules and interventions work best for which patients: if a false alarm is indicated, the doctor can report this. The more patients the system "sees" and the more feedback it gets, the more the system learns. "Normally, the human brain remembers the last 30 or so patients it looked at," says Kreindler. "With this we may have more than 300,000 patients in memory."

Another issue that machine learning is being applied to is the volume and rate at which new medical information is growing. Knowledge is expanding faster than doctors are able to assimilate and apply. It is estimated that in 1950, the time to double the volume of the world's medical knowledge was 50 years; in 2010 it took 3.5 years; and in 2020, it will take 73 days. Doctors just can't keep up. In another study, researchers projected that it took, on average, 17 years for new evidence-based findings to find their way to the clinic.

What if a doctor was able bring up every single case study, clinical study and national guideline worldwide on a particular disorder to the forefront of their mind? The second part of Sentrian's project aims to do just this, and augment the system with the ability to read and learn from all current clinical evidence.

IBM Watson, the supercomputer that won a game of Jeopardy! against humans in 2011, has already demonstrated that this sort of learning is possible. Kohn was chief medical scientist at IBM research, where he led the company's Watson supercomputer initiative in healthcare. Watson has "read" 204 oncology textbooks, medical databases of journals (one of which, PubMed has 24 million citations of biomedical literature), thousands of patient records, and had 14,700 hours of "training" from clinicians. In a study published in 2014, scientists from Baylor College of medicine in Houston, Texas and IBM used Watson technology to analyse more than 70,000 scientific articles to identify proteins that can modify a tumoursuppressing protein. Over the past 30 years scientists have identified 28 similar target proteins - Watson identified six in a month.

'ODD PATTERNS AND
DATA MAY END UP
HAVING SIGNIFICANCE
IN PREDICTING
WHETHER SOMEONE
IS GOING TO
FALL OVER MANY
DAYS IN ADVANCE'

"Watson will assist your clinician by providing timely insights into the specific condition by analysing the patient's detailed medical records including genomic considerations," says Robert S Merkel of Watson Health. "Watson will then suggest potential treatment recommendations from a very large repository of knowledge spanning millions of pages of medical literature, research articles and 180,000 clinical trial protocols."

Merkel explains that Watson does not have to be used as just a tool for suggesting clinical management options to doctors - it could also be a benefit in clinical trials. "Consider clinical trial matching," he says. "A clinical trial for an experimental breast cancer treatment may require a hundred patients who meet a variety of criteria, like a specific genetic marker, age, current stage of the tumour, history of interventions and a response to previous treatments and current medications. Today, physicians and nurses spend hours manually reviewing patient records and comparing patient data to the criteria for a trial. This process introduces the possibility of errors, delays and missed matches." Watson's computing power is able to help doctors by accurately matching their patients with the appropriate clinical trials that could benefit their care.

Sentrian's system is currently undergoing several randomised controlled trials, which means that the data of thousands of patients will be added to the platform. While we wait on clinical evidence, it is just a matter of time before this sort of artificial intelligence becomes a regular occurrence in the doctor's office.



BACTERIA FIGHT CLUB

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Researchers from Vanderbilt University in Tennessee have developed a novel way to create drugs: by organising Petri dishheld "bacteria battles". When bacteria are attacked, they secrete chemicals called secondary metabolites, which can be used to derive antibiotics and other medicines. One battle produced a new type of chemical compound with anti-cancer properties, GV



























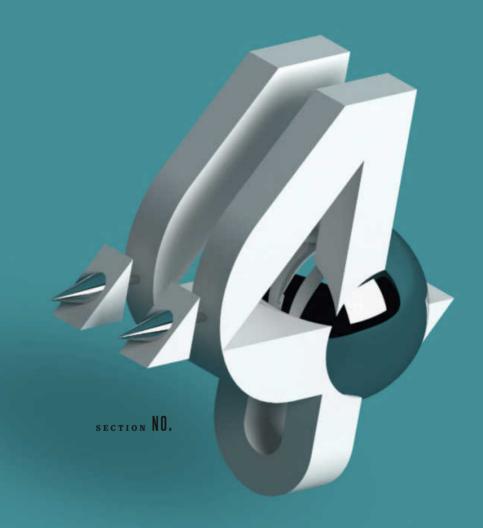
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ENVIRONMENT

FEATURING WRITING BY
YVES BÉHAR
MADHUMITA VENKATARAMANAN
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ILLUSTRATION: Jamie Jones

SPOT ILLUSTRATION: VAHRAM MURADYAN

CONNECTION IS JUST A SCREEN-FREE TOUCH AWAY

Invisible interface technology will allow us to interact with others, rather than be distracted

By Yves Béhar

YVES BÉHAR

_

is founder and principal designer of fuseproject, a design and branding firm, and chief creative officer at Jawbone



The smartphone is perhaps the greatest technological phenomenon of our time. The ability to access the world from a screen in the palm of your hand has been made possible – allowing the paradoxical crossing of globalisation and placelessness. From a technological perspective, this has been inevitable since the rise of the television: the screen provides a sense of immersion that is irresistible to us.

There is an immediate side effect, however: this eternal access means we no longer have to go searching. We can now see almost anything from our smartphone screens. We can text or check someone's social-media feed rather than make a personal visit. We can work from anywhere, learn from anywhere and experience our lives through the little screen in the palm of our hand.

Until now, that's the direction technology has taken us – living and gorging on screens with our heads down in our phones. But 2016 will be the year this changes. Why?

Because we know something is wrong. The loss of humanness is very real. We also know that technology has the profound potential to enhance our experience of the world around us, rather than distract us from it.

I call this the Invisible Interface – a movement wherein technology still provides us with information and gives us command of our surroundings, but through discreet signals rather than screens. It is not that different from the way we orient ourselves in nature: we look at the Sun to understand how much daylight is left in the day; we feel a breeze and turn towards it to scan the horizon for the sign of a storm.

This new approach to the transmission of information is much harder to build than pixels on a screen. And yet it is so much more rewarding for the designer, because the resulting user experience is natural, fluid and non-interruptive. Information and action is then woven into our lives so discreetly that, if it weren't for the magical experiences it creates, we would forget it is there.

The big challenge is that an invisible interface needs to communicate the right signal at the right moment. This means predicting the user's intent to receive the information, and enabling action or command thereafter. It takes a great deal of sensors and software to achieve this, and a good dose of human emotional intelligence too.

An invisible interface can work in any number of ways. Proximity is a good start: products reacting to our physical presence or our movements, signalling and recognising activity. This is what we had in mind in designing the August Smart Lock. What if my door knew that I was approaching, how quickly I was travelling, and unlocked itself for me, just in time?

The technology behind the August Smart Lock is relatively accessible. But design isn't about the technology itself. Design is about ideas. And what design does best is accelerate the adoption of new ideas. The biggest design feat with August was not the hardware or software – although both were more difficult than I could explain. The real challenge was to craft a magical interaction whereby the user receives discreet signals, such as a chime from the lock or a vibration in the phone. These tell the user that the product is taking an action, without requiring an action – in



reality a distraction, from the present moment.

As sensor technology becomes more and more accessible, it will be the designer's job to curate how this information is fed into our lives. By accumulating information and making it relevant to me and the way I live, I am able to make positive decisions and know more about the world around me. That is how technology empowers us.

Current technological offerings are advancing as we speak. Motion sensors, voice sensors and gesture are getting smarter and more accessible. But adoption is still low, and experiences that we can't live without are rare. I believe this is where design is crucial as it has the potential to make technology:

- ▲ Intuitive. If it is more difficult to use than a light switch, it will likely never be used by the whole household, and so never fully integrated into our everyday lives.
- ▲ Empowering. Technology needs to remove complexity. To most of us, technology mostly seems to be adding complexity.
- ▲ Experiential. Technology does not have intrinsic value. It has to deliver value by enhancing the way we experience the world around us.

By removing the display, I hope we will be able to deliver intuitive, empowering and experiential daily moments. As people long for meaningful experiences, for interactions, for presence, there will be a shift toward fewer screens. This is not a shift toward less information. In fact, more information will be communicated in the subtle ways that make us so very human.

GENE-BASED PEST-CONTROL

Agrochemical multinational Monsanto wants to protect crops by harnessing RNA interference: a biological process that can turn off a subject's cellular activity. An insect eating a plant coated with RNA spray would die within minutes. More importantly, RNA can be tailored to affect only certain unwanted organisms. Gian Volpicelli

COMPRESSION CAN EXPAND ENERGY STORAGE

The answer to powering the world could be a mix of renewables and hot air

By Madhumita Venkataramanan

MADHUMITA VENKATARA-MANAN

is head of technology at Telegraph Media Group



DANIELLE FONG WANTS TO REINVENT THE POWER

grid – using air. "We are facing an enormous challenge globally – we are burning through our carbon budget and temperatures are steadily rising," says the 27-year-old energy entrepreneur, who founded Berkeley, California-based LightSail Energy. Her solution: store excess energy in compressed air tanks. "We need to store energy economically – batteries are too expensive and we are not close to the scale necessary to power the world," she says. "Air is inexpensive and lasts a long time, compared to batteries." If energy could be efficiently stored by this method, it could be plugged into solar and wind farms, where it would hoard and dispatch energy when the demand is higher.

In 2016, LightSail's Regenerative Air Energy Storage (RAES) units will be deployed at a half-megawatt scale in California, Hawaii,



Canada and the Caribbean, before 20MW units are rolled out in 2017. LightSail has also integrated its technology with software from Nova Scotia energy storage startup Unify Energy. In 2016, they will deliver their first integrated storage system to the Liverpool Wind Energy Storage Project (LWES) in Nova Scotia – which will be the world's first wind energy project coupled with compressed air storage.

Fong, who studied at Dalhousie University in Nova Scotia at the age of 12, previously worked on nuclear fusion research at Princeton University, but felt it was moving too slowly. "It seemed all the money was in Silicon Valley, so I dropped out and moved there to pitch my idea," she says. It worked: so far she has raised \$58 million (£38m) from investors including Vinod Khosla, Total Energy, Bill Gates and Peter Thiel.

The process uses the electricity from a power source to mechanically compress air and store it in a tank. To get energy back, it expands the compressed air from the tank, which mechanically drives a generator to produce AC power. "Ordinarily, when you compress air, it gets so hot that you could not store or confine it - it's 2,000°C when you compress at 200 atmospheres, so you lose a lot of energy," Fong explains. "So we cool it during compression by spraying water into the air; that has the effect of capturing the heat." The warm water is sprayed back in when the air is expanded. This doubles the current efficiency of this process. "The energy space is a trillion-dollar industry in the making," she says. "Governments will have to take notice. It could transform the world."



ROBOT TRUCKS WILL DELIVER US FROM ACCIDENTS

It's time human error gave way to the self-driving vehicle

By Ben Hammersley



ELEPHANTS & DRONES

-

Tens of African elephants are killed every day by farmers keeping them away from their crops. Resolve. an environmental NGO, is training Tanzania's Tarangire National Park rangers to herd elephants using drones, as the buzz of UAVs greatly annovs hungry pachyderms. GV

SOMETIMES. WHEN YOU GET THE NUMBERS.

things are quite obviously mad. In 2013, in London alone, 187 children were killed or seriously injured in traffic accidents. Four hundred and eighty-nine cyclists died or were badly hurt. Thousands were slightly injured, or nearly missed, or just plain scared. And that's just in one city. Across the UK we live on the shores of inland seas populated by giant chunks of metal controlled by the tired, the distracted and the unskilled. Even though it's a huge improvement on 20 years ago, in 2013 there were still 1,713 people killed on British roads.

We all rely on cars, trucks and buses. From personal commutes and school runs to the final truck-and-van stages of the international supply chain, our society has made a trade-off: there's a certain amount of blood and mourning we'll accept if it means continuing our way of life.

But that's because there's never been a choice. Vehicles have always been controlled by fallible amateurs. Today, we're starting to see the legalisation and roll-out of self-driving vehicles. At the time of writing, the Google self-driving car, for example, has been trialled over nearly three million kilometres of public road, and although it has been involved in 14 accidents, precisely none of them were its fault. In every one, the other car – a human-driven one – drove into it.

Of course, self-driving cars aren't a guaranteed success. People like driving too much. But self-driving trucks? Those are a different matter.

In the inner city, a human-driven truck is an unintended cyclist-killing device. Once self-driving trucks arrive, however, the situation changes entirely. Even a handful of fewer deaths a year, say, and we'll have a statistically provable moral argument. Humans shouldn't be allowed to drive trucks. They will be banned from doing so and 2016 will be the year in which public opinion will begin to sway in this direction.

The shift from radical innovation to societally mandated usage will be swift. First the robot trucks will be a novelty, and we'll be nervous of them. Then we'll marvel at the precision of their driving, and perhaps be unnerved by their law abidance. A few months later, we'll hear of people who were almost, but not, hit by one – telling stories of pedestrian error we've never heard before, because the protagonist was usually killed. Humandriven trucks will start to appear erratic and, given laws demanding drivers stop and rest and eat and such, noticeably more expensive. And then the numbers will come out, and the AI will have been much safer.

From there, it's easy to save 1,000 lives. We'll mandate that only self-driving trucks are allowed in city centres, perhaps with dedicated lanes on the major roads. That will allow for the AIs to go faster than humans safely can, and sky lanes above for local delivery drones. Cyclists can share the streets without worry, AI-flown quadcopter fleets can operate without fear of falling on someone, and the driving of a car can slowly become a fetish activity. It's the future, it's inevitable, and it will save lives.

GREEN LEGO

LEGO will launch its Sustainable Materials Centre in Billund, Denmark, in 2016. Three quarters of the company's carbon footprint results from the drilling and processing of oil, used to make its bricks. The £96m centre will

research new types of non-oil-based plastic, GV

SMART CITIES GET PLANNING PERMISSION

Urban upgrades will be coming to metropolises both old and new

By Madhumita Venkataramanan



PANAMA HITCHHIKERS

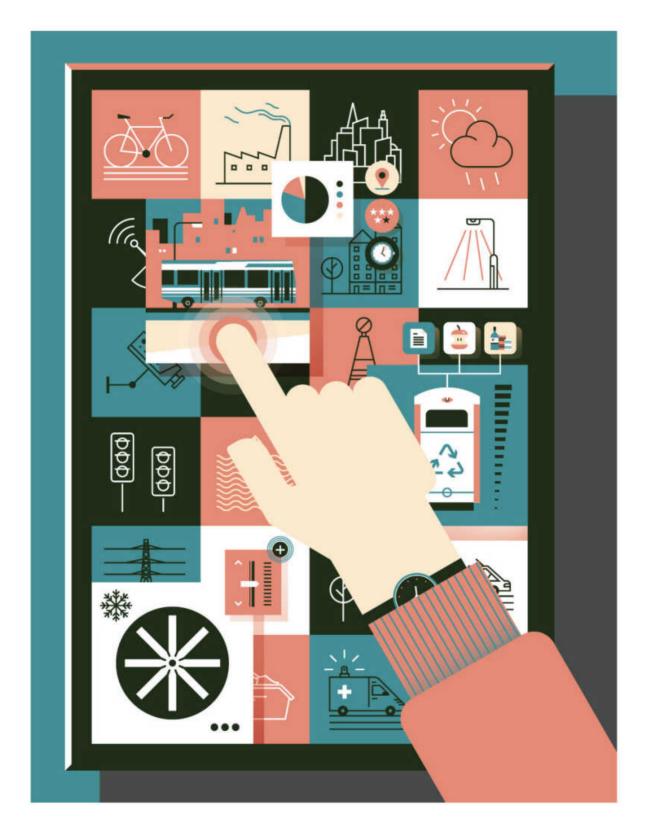
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The Panama Canal expansion project, complete in 2016, will make space for more and larger ships. But, according to a study by the Smithsonian **Environmental** Research Center in Maryland, it will also allow disruptive alien species, such as the zebra mussel, to travel between the Pacific and Atlantic Oceans, attached to hulls and carried in ballast water, GV

IF YOU'RE TRAVELLING AROUND HELSINKI IN

2016, the city's new Mobility-as-a-Service initiative will allow you to simply buy a "mobility" ticket to your destination via text message or app, and the service will plan the ideal route from your starting point, combining public transport, on-demand services and private vehicles. "The price of transport may vary, for instance, based on time or comfort level," says Sampo Hietanen, CEO of Intelligent Transport Systems Finland, and head of the project. The big idea: all public and private transport options will converge around you to get you home on-demand mini-buses called Kutsuplus will deviate according to an optimal route, dropping you off to a public bus stop or a taxi or bike rank. "The city delivers a service to get you home, but it's agnostic to transport type," says John Gibson, director of government innovation at Nesta, who recently completed a study ranking the world's most innovative cities.

Helsinki's data-driven transport system is unique in 2015, but as migration boosts urban populations globally, more cities will need to adapt. By 2030, five billion people will surge into cities. In 2016, more cities will be "smartified" either built from scratch, like Songdo in South Korea, or existing ones upgraded with intelligent infrastructure, such as in Amsterdam. "The word 'smart' is used a lot for cities already, but that's limited to technical data - sensor inputs, control systems, apps," says Gerhard Schmitt, professor of information architecture at ETH Zurich, and leader of the ETH Future Cities Laboratory in Singapore. "Our cities need to be responsive - this is a more human-focused approach, where citizens can give feedback on the functioning of the city to those who run it."



The 670km² state of Singapore is the poster child for a city in upgrade mode. "We are not supposed to be here," Vivian Balakrishnan who was minister for environment and water resources until October 2015, as well as the head of the Smart Nation Initiative - told the audience at an innovation event that WIRED attended in April 2015, "What you see in Singapore is an exercise of desperate imagination. It's not about innovation because it's sexy, but because it's survival." His plan: to turn Singapore into the international guinea pig for smart technologies. "We are trying to virtualise the whole city," says professor Low Teck Seng, CEO of the National Research Foundation (NRF), the national research funding body. "We will be building 3D models of each building, including glass, cement and the internal geography of the building. We will integrate live data from cameras and can use it for traffic or disaster management."

In 2015. Singapore's government wired up a single precinct - the Jurong Lake District - to use as a test bed for a range of urban digital experiments. Over 1,000 sensors were deployed to monitor everything from traffic to street lights. New data hubs, known as Above Ground Boxes, provide high-speed fibre connectivity and power at the street level, and accommodate all the sensors. An automated sanitation system, built by local institution Temasek Polytechnic and ZWEEC Analytics, is being tested to determine the cleanliness of public areas by using advanced video analytics and smart bins. A driverless buggy built by the National University of Singapore and Singapore-MIT Alliance for Research and Technology (SMART) is already ferrying passengers.

Autonomous vehicle trials have now expanded to university campuses around Singapore and, in 2016, will be tested in the One-North district, a hub for biotech, media and R&D companies. "A recent paper by the SMART team showed that the mobility demand of a city such as Singapore could be met with 30 per cent of its existing vehicles," says architect and smart-city researcher Carlo Ratti. And this seems to be the goal of the Singaporean government. "We don't want to increase the number of cars on our roads," says Professor Seng of the NRF. "Autonomous public transport makes more sense than autonomous private cars."

About 65km southwest of Seoul in South Korea, another city has taken a very different approach to getting on the digital grid. It's being built from scratch on 600 hectares of reclaimed land, with sensors, high-speed fibre optics and high-tech public urban systems designed in. "From an infrastructure perspective, we could lay the very latest connectivity technology into the ground before construction," says Tom Murcott of real estate developer Gale International, which is building the Songdo International Business District. Partnering with Cisco, Gale has spun out a separate company called u-Life Solutions that will provide the internet-of-things backbone for Songdo's buildings. "This will allow the occupants to control their air conditioning, their televisions, even their elevators," Murcott says. "Cisco also built an HD telepresence system that we have installed in 14,000 residential units, which citizens can use to interact with city administrators, local shopkeepers, or healthcare workers." To run services such as waste disposal, engineers designed a pneumatic system that uses pipes to suck rubbish from homes into processing centres that sort the material and recycle it. "In 2016, there will mass implementation of all these services, and new ones being prototyped by SparkLabs, a Korean hardware incubator whom we are working with," Murcott says. "Songdo has this 'living lab' aspect - there's a pioneering spirit in the people who move here."

It's not only developed economies that are reinventing urban living. Large, growing cities in developing countries are also adapting. "Sensors with sophisticated control systems can work in cities such as Melbourne or London or Sydney, but 90 per cent of people in cities don't live in cool, temperate climates - they live near the equator and there, most of this smart tech does not apply," says Gerhard Schmitt of ETH Zurich. "These cities can be smart, but the innovations need to be affordable and useable." Schmitt's lab has projects underway in 20 equatorial cities including Addis Ababa, Lagos, Mumbai, Yangon and Jakarta. "In Addis Ababa, there is a long-term development project called Addis 2050," Schmitt says. "We will be partially implementing plans related to a sophisticated new energy grid in the city over the next year."

Ultimately, though, it's not enough for a city just to have "smart" technologies. "We need to use cognitive designing as well – citizens should be involved in design of their cities," Schmitt says. "Technology will just extend and support human sensors." 2016, then, will not just be the year of smart, but of transhuman cities.



THE OCEAN

Boyan Slat, a 21-year-old Dutch inventor, plans to clean plastic waste from the oceans by exploiting the currents. In summer 2016, Slat's organisation, The Ocean Cleanup, will test a 2km barrier for floating rubbish in the waters around the Tsushima island, near Japan, GV

The fridge needs help. Because much of the energy we need to power it produces waste, pollutes the atmosphere and changes the climate. We can transition the way we produce and use energy in a way that will contribute to a sustainable future. We're campaigning in countries all around the world to provide the solutions for governments, for companies and for all members of society to make the right choices about energy conservation and use. And you, as an individual, can help just by the choices you make. Help us look after the world where you live at panda.org



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THE CARBON CONUNDRUM

Everyday life runs on energy – which can also mean CO_2 emissions. But what if we could stop CO_2 from ever reaching the atmosphere?

If you think about your every day life — the smartphone you use, the machine that brews your coffee and the transport that takes you to and from the office — it's all powered by energy. As the number of people on the planet increases, so will the desire for goods and services — and the need for energy. Meeting growing

energy demand while limiting CO_2 emissions is a global challenge for both society and business.

"We have long recognised both the importance of the climate challenge and the critical role energy has in enabling a quality of life that people deserve, wherever they live," says Tim Bertels, Shell head of CCS (more about which later). "By 2050, our world could be home to nine billion people – that's almost two billion more than today. All energy sources will be needed to meet that demand while addressing environmental stresses."

So what's the answer? One option is using a technology called carbon capture and storage (CCS). This is a method of capturing CO₂ emissions generated by energy production and industrial processing sites such as power stations, and sequestering it deep underground again. After all, that's where hydrocarbons – oil and natural gas – were for millions of years before they were extracted.

"The availability and reliability of hydrocarbons are important factors to help ensure that everyone has access to energy, and they can be used to complement the increasing proportion of renewables in the mix. To address the challenge of increasing energy supply – but reducing CO_2 emissions – it is essential to make hydrocarbons cleaner. CCS helps achieve this," says Bertels.

Several respected international bodies agree that CCS is a highly desirable development in energy production. The International Panel on Climate Change estimates that without CCS the cost of limiting the global temperature rise to 2°C would be around 138 per cent higher. The International Energy Agency (IEA – an autonomous intergovernmental organisation founded in 1974) estimates that CCS could deliver about a fifth of necessary worldwide reductions in greenhouse gases by 2050, and a half by 2100.

Bertels sees the environmental and financial savings: "The scale of potential future deployment of CCS is enormous, spanning manufacturing, power-generation capture, transport and storage developments worldwide." The IEA estimates the costs of



Banff National Park in Alberta, Canada

achieving global climate objectives without CCS to be over 40 per cent higher. The Energy Technologies Institute found that without CCS the additional costs needed just to run a decarbonised UK economy in 2050 would be £32 billion per annum.

CCS is already in action at the Shell Quest CCS project, at the Scotford Upgrader north-east of Edmonton, Alberta. The Scotford Upgrader processes bitumen produced from the oil sands in northern Alberta. With Quest, CO_2 is captured from the upgrading process and stored underground more than 1.2 miles below the Earth's surface. Shell is on a quest to capture and store about a million tons of CO_2 each year, equivalent to

QUEST WILL CAPTURE ABOUT A MILLION TONNES OF CO₂ PER YEAR, EQUIVALENT TO TAKING 175,000 CARS OFF THE ROAD



HOW CCS WORKS

There are three opportunities to capture carbon-dioxide emissions before they can reach the atmosphere



taking approximately 175,000 cars off the road. The Quest project has benefited from CAN \$865 million of investment from the Canadian and Alberta governments.

Similarly, the proposed Shell and SSE CCS project at Peterhead Power Station, near Aberdeen in Scotland, could result in the capture of up to ten million tonnes of carbon dioxide emissions over the project's lifetime. The emissions would be transported offshore by pipeline for long-term storage deep under the North Sea.

Shell will share the learnings from its CCS projects to help enable more CCS projects to be developed. So, how does CCS work?

There are currently three types of carbon-capture techniques in operation around the world. These include pre-combustion, post-combustion and oxyfuel combustion (see right). Once captured, the $\rm CO_2$ is condensed into a liquid and transported via pipeline or truck to the chosen storage site.

When stored in a reservoir after being captured from an industrial plant, CO_2 would be held in place by an impermeable cap rock. This type of rock held the natural gas securely in the reservoir for millions of years. The reservoir pressure is then kept within safe limits.

Shell will help provide those solutions to bring more energy and less CO₂, especially in areas where we have, and can develop, skills such as natural gas production, future fuels such as biofuels and hydrogen, and CCS. Shell will do it because it knows that its long-term viability as a company depends on its ability to anticipate the types of energy that people will need in the future, in a way that is commercially competitive and environmentally relevant.

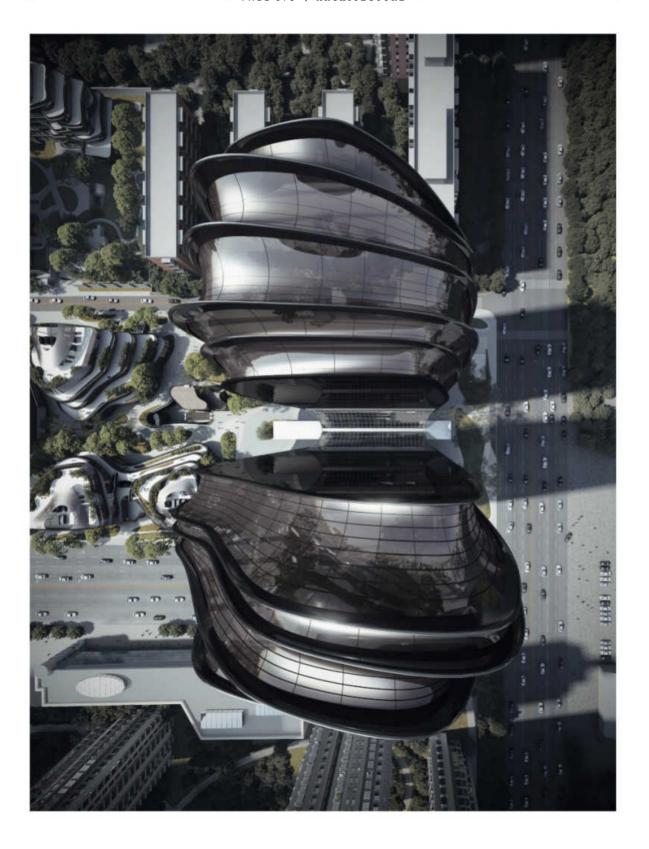
CCS is projected to be a critical tool in the quest to power the planet and enable human progress. It gives us the best of both worlds, which is important because we are not lucky enough to have two Earths.

Pre-combustion Upgrading a barrel of crude oil includes adding hydrogen. Making that hydrogen is one of the primary causes of high CO. emissions in the oil upgrading process. This is the first opportunity that CCS presents: pre-combustion. This is when CO is removed at the point of making hydrogen - before the combustion of the fossil fuel.

Post-combustion
After the oil is
upgraded it is
transported and
used for a range
of different
products and
applications.
One of these
is generating
electricity, which
involves burning

the oil and releasing CO₂ emissions. This is the second opportunity to use CCS: post-combustion. Here, it is captured after the combustion of the fuel, but before emission.

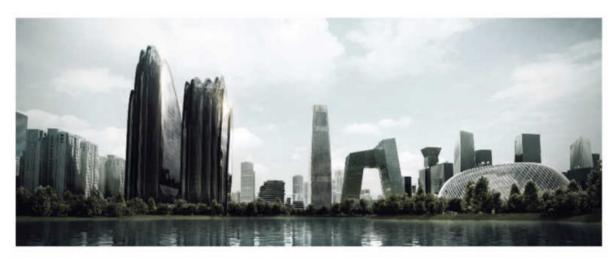
Oxyfuel combustion In the case of oxyfuel combustion, pure oxygen (O_o) is used rather than air when the fuel is combusted. This produces exhaust gas that is mainly water vapour and CO, that can be easily separated to produce a high purity CO. stream. This can then be piped underground to a secure storage site.



THE RISE OF NATURAL ARCHITECTURE

Founded by architect Ma Yansong, Beijing- and Los Angeles-based MAD has designed many of China's most exciting new buildings. Incorporating "shanshui city" principles – bringing nature into urban areas – the firm's work is forward-looking, while also referencing eastern culture and art. Here are four of its projects under construction.

By Gian Volpicelli





CHAOYANG PARK PLAZA

Once completed in 2016, this complex will rise 120 metres above Beijing's central business district, and will include 120,000m² of offices, shops and residential buildings. MAD designed it as a "shanshui city" – an in-house concept that brings nature into urban environments. So here, the buildings are modelled on the types of natural landscapes seen in traditional Chinese paintings.



HUANGSHAN MOUNTAIN VILLAGE

This residential project in Anhui province is designed to blend into a background of limestone cliffs and green hills. It will provide housing, a hotel and amenities for the many tourists visiting the nearby Huangshan mountains. The use of locally sourced construction materials and the incorporation of plants in all the balconies are intended to boost its closeness to nature.

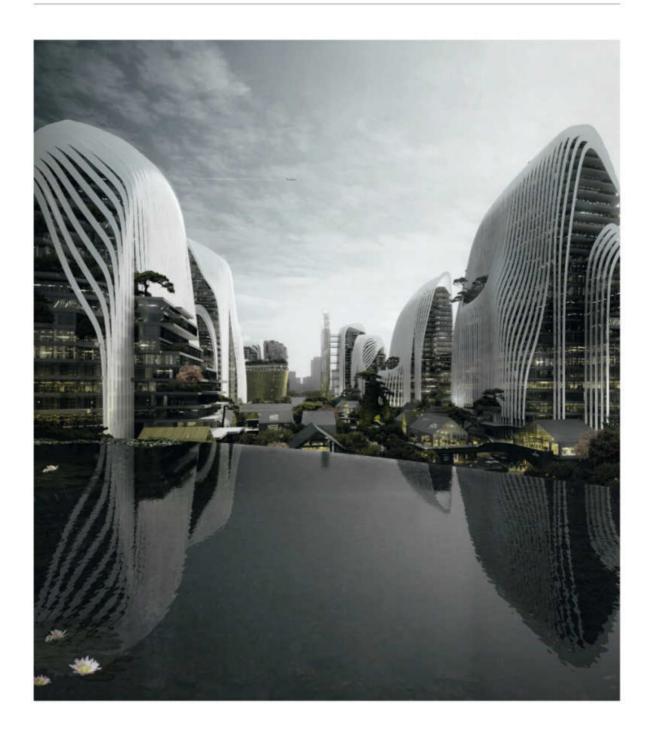






HARBIN CULTURAL ISLAND

The city of Harbin, close to, and culturally influenced by, Russia, is considered northern China's music capital. This new 79,000m² cultural centre – located in the natural landscape of Sun Island, by the Songhua River – will have two theatres, with a total of 2,000 seats. The buildings' mountainous shapes and stone-and-aluminium exteriors reference the snowy peaks in the distance.



NANJING ZENDAI HIMALAYAS CENTER

This 560,000m² commercial complex in Nanjing is also influenced by MAD's "shanshui city" concept. Made up of six units connected by gardens, footbridges and plazas with flowing water, the project harks back to the idea of a hillside village, where people can wander and meet freely. The simplicity of its design is echoed by the choice of smooth concrete for much of the construction.



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FROM
FRICTIONLESS FINANCE
TO
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HERE'S PROOF YOU'LL BE SPENDING MORE MONEY

Digital wallets will make spending a frictionless experience – but is that actually good for us?

By Dan Ariely & Merve Akbas

DIGITAL WALLETS HAVE LONG BEEN CONSIDERED

to be an ideal of modern life. Apple Pay, Android Pay and the other, similar, platforms available in 2016 will mean that we will deal less with cash - we will be freer, more flexible, spend less time on managing our money, and have a much clearer understanding on what we spend our money on. A sort of utopian era of technological bliss. The queue at Starbucks will be shorter. We won't have to wait to sign the credit-card receipt at the end of a nice dinner. We won't miss the Tube while trying to top up our Oyster cards. And that is just the start. As these digital wallets, and others, develop further, much of the hassle involved with paying could be eliminated. A post-money economy would be upon us.

But, is this kind of future good news for us? Do we truly want to eliminate all the friction that comes with spending cash and swiping credit cards? In 2011, a study published in the journal *Obesity* described an experiment in which some people got one 400g bag of

DAN ARIELY & MERVE AKBAS

Dan Ariely is professor of psychology and behaviour at Duke University. Merve Akbas is a PhD candiate in economics





crackers, while others got the same quantity of crackers, but in four separate, 100g bags. In which of the two cases did people eat fewer crackers? You guessed it: when the crackers were given in four bags. What made them stop sooner? When crackers were divided into multiple bags, people stopped at the end of a bag. We call this the "decision point". When we get a large bag of crackers, we sit watching a movie and just eat without thinking much. But, when the bag is finished, we stop. And when we stop we think. And, as we think, we are more likely to ask ourselves if we really want to stop or continue. Sometimes we conclude that we should stop (and, quite often, we actually do stop).

If we approached cracker consumption in the way we're currently thinking about digital wallets, we would be trying to build cracker dispensers that give people a continuous supply of crackers without thinking much and while minimising physical effort. But is this the world we want to create? When it comes to crackers, it seems clear that a world in which people eat crackers without thinking is not a good world for the individuals in question or for society (though it might be good in the short-term for the people producing crackers).

The importance of slowing down to think is important for cracker consumption, but it applies with even more force to money. Some friction, and the need to stop and think can, in fact, be good for us. Saving money is already very hard, as we compare something that we want right now – and we can almost taste and feel it – to something abstract that we might get in the future if we forgo the purchase and save the money. Do we really need to make the process of spending any easier?

In the money domain, the feeling we get when we stop to think about spending is called "the pain of paying". This is a sort of agony that we feel when we think about parting with our cash. It is the feeling that we have when we pay in notes and coins at the end of an expensive meal, compared with paying for the same meal with a gift certificate or a credit card. It is basically the unpleasantness that comes with thinking about the money that is leaving us – and the more we think about it, the more pain of paying we get, and the less fun and exciting the purchasing becomes.

With this understanding of the pain of paying in mind, it is all too obvious why retailers and

CYCLE IN SAFETY

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Transport for London (TfL) plans to complete four bicycle-only superhighways by the end of 2016, intending to make the capital safer for cyclists. The two largest cycleways will cut through the city north-south and east-west; all the lanes will run parallel to roads, in order to speed up the traffic and reduce accidents involving bikes and vehicles. GV

credit-card companies want digital wallets to eliminate the pain of paying. But, do we - as the people using digital wallets to part with our money - want the same process? Whereas the pain of paying can make us feel guilty after an expensive dinner, it can also prevent us (to some degree) from impulsive shopping. In a future with digital wallets the way that they are envisioned now, and with almost all frictions eliminated from the payment system, we are likely to fall for temptation at a much higher rate. It will be almost as if we got to spend the whole day sitting on a table full of fresh doughnuts, cheesecake and truffles, all within reach. The result? Not good for our long-term health or savings rates.

The idea that electronic wallets should get us to think about money does not end with thinking about spending. What about savings? Could we add things to electronic wallets that would change the way in which we think about savings, and by doing so make us save more? Saving is an area of life that doesn't cross our minds very often, and even when it does, it rarely produces increased results. To test the extent to which the design of digital wallets could influence savings behaviour, Duke University conducted an experiment with more than 2,000 customers of a mobile money savings plan in Kenya. We randomly assigned participants to receive one of many different services from the savings plan. Some participants received two text messages every week: one at the start of the week to remind them to save and another one at the end of the week to report a summary of recent savings.



MAYO ON DEMAND

A slippery technology will help us extract that last smidgen of mavo from the bottle. LiquiGlide, a Massachusettsbased firm that commercialises an anti-adhesive material developed at MIT, has struck a deal with Orkla, a Norwegian packaged-food company. Orkla will use the substance to coat the inside of mayonnaise bottles it sells in Europe, ensuring every last drop ends up in your sandwich. GV

In addition to these text messages, other participants also received a gold-coloured coin with 24 engraved numbers (the numbers one to 24), to indicate the 24 weeks that the plan lasted. At the end of the week, if these participants had saved money, they were asked to take a sharp knife and scratch the number for that week in a way that indicated what they had saved during that week. Other participants got a different type of reminder message: a text that was framed as if it came from the participant's child, asking them to save for "our future". Yet another group of participants got a match for their savings. They received a bonus of ten per cent of their weekly savings, deposited in their account at the end of each week. There was also a group of participants who received a 20 per cent match. (We had some other conditions as well, but they did not end up being that interesting.)

At the end of six months, the service that performed spectacularly better than every other service was... the coin. Every other service, that is the text message from kids, the extra deposits and our other approaches, increased savings only slightly. Those who received the coin saved, on average, about twice as much as those who only received the simple messaging service.

How did a simple coin make such a difference in behaviour? We believe that it made the act of saving salient by changing what people were thinking about as they were going about their day. From time to time they saw the coin in their hut; from time to time they touched it, talked about it. By being physically present, the coin brought the thought about saving, and with it the act of saving, into participants' daily life.

How will our relationship with money evolve? With digital wallets, we are exploring a completely new medium – and this is a good point to ask how the future might be shaped. The answer is that it will depend on design. If the people putting these products into the market focus on minimising friction and thought, then more money will be spent with less thought and attention. But, if we understand the places where we fail when it comes to thinking about money and try to use technology to augment our memory and attention in order to help us think better, the future might be much better.

Dan Ariely's latest book, Behavioural Economics Saved My Dog, is out now (Oneworld)



NEW TRUST NETWORKS: YOUR BEST FRIEND IS A STRANGER

Online person-to-person interactions are setting the stage for more honest offline human behaviour

By Rachel Botsman

RACHEL BOTSMAN

is an expert on the collaborative economy



DURING A RECENT FAMILY DINNER TO CELEBRATE

the engagement of my cousin Anthony, the happy couple ceremoniously picked up their phones and deleted *Tinder*, the dating app on which they met. "We've gone from hook-up to chuppah in less than six months," Anthony declared in his toast. Intrigued, I asked them how many messages they exchanged before they met face-to-face. It turned out they had sent more than 150 texts to each other, over the course of three days. "I started to share genuine things about myself that I would normally keep

hidden for some time," his fiancée told me. "I felt like I didn't just know him, but actually trusted him." Anthony and Emily essentially met the person they plan to spend the rest of their lives with by swiping right. Their engagement represents not just a digital-age acceleration of intimacy but a world in which the speed and nature of trust is being fundamentally redefined.

Tinder and other dating apps are a green shoot in our understanding of how trust formed between people online can transfer into the real world. On the flip side, we are in the early stages of seeing how real-world interactions could change trust online. Take Alan, a 42-year-old Airbnb guest I recently met, who was highly sceptical of renting a home from a stranger. The place turned out to be much better than he expected. "The experience changed my assumptions," says Alan. "I was clearly wrong."

That one good travel experience could effectively be the gateway to persuasion, positively influencing Alan's trust in the online world and changing his behaviour around everything from believing strangers' reviews on products and services to trusting cryptocurrencies that have no traditional entity to trust. A new trust framework is emerging, fuelled by social, economic and technological forces that will profoundly change not just how we are trusted in the world, but how we view trust in the world.

Understanding of, and research into, the interaction between technology and trust is still in its nascent stages. Stanford University sociologists Paolo Parigi and Karen Cook are studying communities that include couch-surfing and dating sites. "We have some preliminary research confirming the idea that people's levels of trust towards others can be modified through the experience of participating in this relatively new form of collective action," says Parigi. "If confirmed in subsequent research, the implication is that trust can be engineered and that technology can play a crucial role."

As I researched platforms that depend on person-to-person trust, I saw that there is a common pattern. In the first layer, people have to trust that a new idea will work and is safe. The next layer is trusting the platform or third party facilitating the exchange. And the third layer is trusting the other user. I call this process the trust stack. Take the French long-distance ride-sharing startup BlaBlaCar, now connecting more than two million drivers and passengers every month. At the outset, you

have to dismiss the warning most parents give their kids: never get in a car with a stranger. You trust that ride-sharing is a safe idea. Then you trust the platform will not only weed out the bad apples but will help you fix any problems. Finally, you trust the driver and passengers that you will share a ride with will be good, honest people. Over time, people open up to changing their behaviour the more they live in these trust structures. So sharing a ride with someone you don't know can become as normal as driving alone.

As people repeatedly go through the trust stack in different areas of their lives, the process and comfort of using online/offline trust to make decisions accelerates. A regular BlaBlaCar user is likely to be more open to finding a lawyer on a marketplace such as UpCounsel than going with a bricks-and-mortar firm. Digital tools are raising our levels of trust in others in ways that are speeding up the disruption of an old norm and accelerating the adoption of new ideas.

This is a threat to big organisational systems - universities, corporations, banks, healthcare, even licensed taxi associations - that have depended on people placing value in the belief that traditional safeguards and centralised guarantees will keep them safe and render goods and services reliable. As this traditional institutional trust framework continues to crumble, it creates fertile ground for technology-engineered decentralised trust directly between people. Prepare for 2016 to be a year when incumbents across industries realise that the real disruption taking place is not technology; it's a trust shift that will open the doors to completely new - and sometimes counterintuitive - ways of designing systems that will change human behaviour on a large scale.

Rachel Botsman is co-author of What's Mine is Yours: The Rise of Collaborative Consumption (Harper Business)

JET PACKS TAKE OFF

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New Zealand-based Martin Aircraft will release a commercial jet-pack in 2016. Costing \$200,000 [£130,000], it will be initially aimed at "first responders", such as fire fighters and emergency services, with a civilian version in 2017. GV



VR ZOO

Landmark Entertainment Group, a California-based production company, will build a zoo for CGI animals. The zoo will be part of a \$200m VR theme park, due to open in a still-to-bechosen location in China between mid-2016 and early 2017; the

park will also

include a virtual

aguarium and an

art gallery, and

of animal

has the approval

rights groups. GV

DANIEL NYE GRIFFITHS

is a WIRED contributing editor



THE ONLINE JUNGLE WILL BECOME A TAD LESS BRUTAL

Post-Gamergate, abusive behaviour will be taken far more seriously

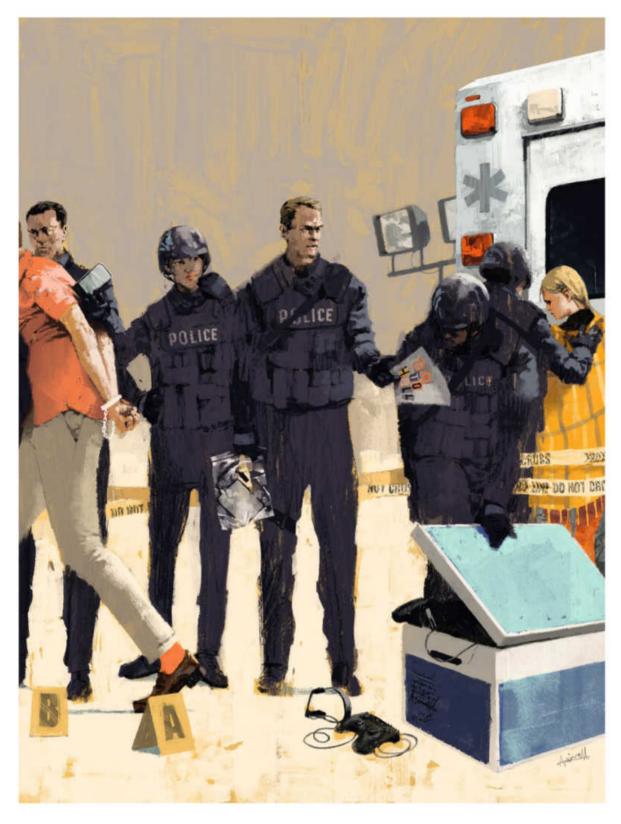
By Daniel Nye Griffiths

IN JUNE 2015, A CANADIAN TEENAGER AWAITING

sentencing for harassment, hacking and hoax calling (we can't name him due to his age) explained to the court why he had terrorised women he met through the game *League of Legends*: he was bored. Among his techniques was "swatting" – using fake emergency calls to send armed police to a victim's home, expecting armed resistance.

In recent years, swatting, along with doxxing - releasing somebody else's private information online - and threats of death, rape and violence have become increasingly prevalent. Targets have been as diverse as Olympian Tom Daley, historian Mary Beard, actress Zelda Williams and Labour MP Stella Creasy. In many cases, these threats were delivered using Twitter and other social networks, leading a frustrated Dick Costolo, then Twitter CEO, to exclaim in a leaked memo: "We suck at dealing with abuse and trolls on the platform and we've sucked at it for years."

Costolo's memo was widely supposed to be related to the "Gamergate" controversy, which made headlines in autumn 2014. Representing a loose confederacy of socially conservative gamers and developers, right-wing pundits, men's-rights activists and opportunists, the hashtag - coined inexplicably by the actor Adam Baldwin - acted as a rallying call across online communities against progressive voices in gaming and beyond. Many of these voices, including the initial targets, video-game developer Zoe Quinn and feminist critic Anita Sarkeesian, had experienced abuse from similar sources before. This episode, however, pushed online harassment on to the front page of the *New York Times*



Increased vigilance for online harassment also means harsher penalties for perpetrators

and sparked a debate on the obligations of internet businesses to protect users.

In the aftermath of Costolo's memo, Twitter has enhanced its reporting mechanisms, introduced content filters and made it possible for friends to share collective block lists – a feature previously offered by third-party services such as *Block Together* and *The Block Bot*. Google has declared that it will no longer list "revenge porn" – sexually explicit photographs shared often by angry exes – in its search results. Even 4chan and reddit, traditionally hands-off in their administration of content, have started to delete forums and ban users advocating harassment, or co-ordinating attacks on individuals.

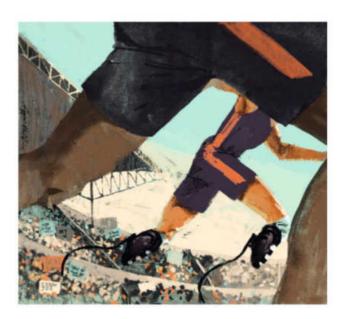
The eyes of government have also turned, slowly, towards the issue. Baroness Shields, former head of Facebook Europe, has joined the Cabinet as Minister for Internet Safety and Security. Her wide brief ranges from protecting children online to removing "extremist" content. In June 2015, New Zealand's parliament voted through a bill punishing cyber-bullying with up to two years in jail, winning praise but also raising privacy and concerns about free speech.

Simon Milner, Facebook UK's director of policy, is also sceptical of the benefit of governmental strong-arm tactics: "There are some countries that think they need to reach for the legislative toolkit, but we haven't seen any examples of a country successfully doing that," he tells WIRED. "What works better is dialogue based on trust, where tough questions are asked, but everyone works together."

Given the sheer volume of online traffic, human solutions need to be supplemented by better and smarter automated responses.

Riot Games, maker of *League of Legends*, has implemented a range of social engineering initiatives, reporting tools and peer reviews to clean up its community. With more than 7.5 million playing simultaneously, hand-fixing every issue would be hugely labour intensive.

Riot's latest innovation is a system that scans messages flagged as offensive and automatically contacts the sender with a breakdown of where they crossed the line. As machine intelligence becomes cheaper and faster, harassing behaviour will be identified and neutralised before a human even encounters it. The technology is maturing, and the political will seems to be present. 2016 will be the year when a mixture of human action and algorithmic herd immunity will be brought to bear on harassers.



YOUR BODY IS NOT ENOUGH

Enhanced 'cybathletes' won't just be beating their able-bodied rivals – they'll improve life for everyone

By Kathryn Nave

KATHRYN NAVE

is a regular WIRED contributor



IN 2012, A SINGLE PAIR OF PROSTHETIC LEGS

ignited an international debate. Did South African athlete Oscar Pistorius's carbonfibre running blades confer an unfair advantage over other able-bodied competitors? Did this assistive technology, the International Olympics Committee asked, take him beyond normal human limits?

For the Cybathlon, a new international sporting event taking place in Zurichin October 2016, the question of limits is entirely beside the point. "At Cybathlon we allow any kind of technology," explains the event's founder and organiser Robert Riener, a professor of sensorymotor systems at ETH Zurich. Technology such as non-invasive brain-computer interface (BCI) caps, with which participants compete

to control a computer game avatar with their mind. Or functional electrical stimulation, used by patients with lower-body paralysis to activate their muscles and pedal recumbent bikes around a track. Experimental new designs in powered exoskeletons, leg prosthetics, arm prosthetics and wheelchairs will be tested not only for speed and flexibility, but also their ability to cope with the kind of daily tasks, such as climbing stairs or opening a jamjar, for which current prosthetics are so inadequate.

"Allowing things such as motors and BCIs means we can include patients with more severe disabilities, patients who are almost totally paralysed," says Riener. "It's about showing the skills that our athletes can have in combination with technology." The best comparison, he suggests, is Formula One racing - there are awards for both athletes and the technology. And, just as technology such as carbon fibre and traction control - developed by teams of world-class engineers for the sole purpose of getting their car round a track faster than anyone else - has changed the vehicle we drive, so Riener hopes the competitive spirit of Cybathlon could produce innovations that reshape humans bodies themselves. "Only a quarter of arm amputees are using a prosthetic," he says. "There is a great need to improve these technologies. In the long run we hope that the devices developed for this competition will become available, affordable. and will improve people's quality of life."

Although the competition is geared towards daily obstacles, the challenges are not trivial, explains Aldo Faisal, senior lecturer in neurotechnology at Imperial College London and captain of the university's Cybathlon team. "In the prosthetic-arms race, you have to move a ring around a metal hoop without the two touching. Myself and another able-bodied colleague couldn't do it," he says. "Putting this equipment to the test in these sorts of events challenges engineers not just to make something that looks nice from an aesthetic point of view, but that can really compete in a more rugged sense."

If this equipment is to make it outside of the lab to the people who need it, affordability is a key concern. For the powered wheelchair race, Team Imperial took a standard, commercially available chair and hooked it up to a specially developed eye-tracking system, which costs just £20 to produce – around 800 times less

than comparable equipment. "It surprised me how good the control with the eye-tracking actually is," says the team's wheelchair pilot Sivashankar Sivakanthan, whose spine was reconstructed with titanium following damage caused by a tumour in his Tl vertebrae. "I just look where I want to go and the chair will take me there. It required ten minutes of getting used to and then I was away. That is what this technology should be about. It should be easy and versatile, where you can implement it in real life for severe patients."

Although Sivakanthan is not paralysed himself, the team are excited about the potential applications for those who are. "We have people able to lift two tonnes with the support of a full-body exoskeleton," Faisal says. "If we incorporate eye-tracking or brain computer interfaces instead of joystick control, then we could have a paralysed person working at, say, a shipyard, with many times the strength of the average man. This technology is non-invasive. We're not going to be seeing cyborgs running around half-cut-up to accommodate this tech. We're talking about things you can basically step in and out of."

The Cybathlon has already achieved its first aim of spurring new research. "We have 60 international teams coming, many of whom have already started to develop novel technologies," Riener says. Next is making sure these innovations and their application get the attention they deserve. Riener is currently in negotiation with the organisers of the Summer 2020 Olympics in Tokyo, who want to run the Cybathlon in the same year. "Exoskeletons are often presented in relation to the military," says Faisal. "It's important to show the civilian, pacifist uses this technology can have . For that, Cybathlon is a beautiful vehicle: a peaceful, friendly competition, just like in the Olympic spirit."

3D BILLBOARDS

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Scientists at the Vienna Technology University have developed billboards that show 3D images without the need for special glasses. The board's 3D pixels - or "Trixels" use lasers and movable mirrors to send slightly different images to each of the viewer's eyes. GV



PREDICTIVE MECHANICS

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American car maker Chevrolet has announced a new optional technology for 2016 models. Built-in sensors will monitor the battery, starter motor and fuel pump, and send the data to Chevrolet's servers, where it will be used to assess whether and when a part is likely to fail. GV

AN INTERNET OF HACKABLE THINGS

Without proper security, we're building a network packed with vulnerabilities

By Marc Goodman

WHEN MOST PEOPLE THINK OF CYBERCRIME,

they think of hackers raiding bank accounts, stealing identities and pilfering credit-card numbers. Ah, the good old days. We'll come to miss them, given what lies ahead.

There is a fundamental paradigm shift afoot in the world of digital crime, and it will make us pine for the simplicity of credit-card theft. Throughout the history of hacking, most of these threats have been constrained to the two-dimensional world of computer screens. The danger was only to our data. But, as the fundamental nature of the computer shifts, so too does the threat landscape.

To most, a computer is a desktop machine, laptop or server. More recently, we have come to recognise that our mobile phones, tablets and gaming consoles are also computers, as are any objects with the word "smart" – televisions and watches. As the investor Marc Andreessen famously noted in 2011, "software is eating the world." In other words, the physical objects in our world are slowly transforming into information technologies, a phenomenon referred to as the internet of things (IoT).

The possibilities of the IoT are significant – your Nest thermostat will save you money on your energy bill, your Fitbit will carefully monitor your activity and your car will drive itself (and you) to the office. The IoT is expected to be worth \$11 trillion (£7.1tn) to the global economy by 2025, as factories modernise, city infrastructures go online, and the world of logistics is completely transformed. Intel estimates 200 billion new objects joining our global information grid by 2020.

But let's remember all of these devices are also computers and, to date, no computer has been built that could not be hacked. In July 2015, hackers remotely commandeered

MARC GOODMAN

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a Jeep Cherokee as it drove down a highway at 110kph and killed its engine mid-stream, bringing the vehicle to a sudden halt. Modern automobiles are no longer purely mechanical devices: each has hundreds of computer chips in them, controlling everything thing from airbags to windscreen wipers. Today's cars are nothing more than computers we ride in.

Computers that we fly in are also subject to hacking. Recently, the FBI detained a computer security researcher who claimed to have accessed data from a United Airlines flight's engines, mid-flight, while seated on an aircraft as it flew from Chicago to Denver. The breach reportedly occurred when the hacker plugged his own laptop into an available port underneath his seat, bypassing the in-flight entertainment system software to access the plane's flight management system.

The possibilities for disaster are manifest. In this brave new world, when cybercrime goes 3D, identities aren't stolen – lives are lost.

Though more and more of the inanimate objects in our lives are becoming "smart", there is no guarantee they will remain loval. Home networks can be subverted via Nest thermostats, not only allowing hackers to remotely raise your heating while you're on holiday, but also to know that you are out in the first place by seeing the device has entered "away mode", a perfect time for burglars to visit. In retail, point-of-sale terminals are vulnerable: in 2013, 100 million US customer accounts were breached when hackers subverted a third-party contractor's data systems to gain access to the tills. With billions and billions of new devices coming online, it is near impossible to map the network complexities of this world - a building's air conditioning unit may well provide a point of entry to a store's customer data.

Despite this, the promise of the IoT drives us to connect an increasing number of devices to the internet. And as we do, more and more objects are being hacked. Smart light bulbs with poor encryption can leak a router's administrative password. Baby cameras and nanny cams have been subverted by paedophiles and others to spy on children. Networked printers can not only leak documents for purposes of industrial espionage, but can have their firmware remotely attacked, causing fusers to overheat and catch fire, allowing hackers with a touch of pyromania to start fires remotely inside offices or homes. And whereas smart refrigerators that re-order

eggs and milk when you are running low sound great in theory, a persistently connected fridge can also be attacked and become enslaved in a botnet, using its processing power and connectivity to send out millions of spam messages for Viagra while you sleep in the next room.

Not only are we riding and flying in computers, we are increasingly placing them in our bodies as well. Pacemakers, diabetic pumps, implantable cardiac defibrillators and cochlear implants too are connecting to the internet – and hackers are not far behind, as demonstrated frequently at conferences such as BlackHat and DEF CON. Our wearable fitness devices can be compromised as can those implanted in our bodies. As man and machine merge, we are increasingly becoming cyborgs and the result is that now for the first time in history, the human body itself has become subject to cyber attacks.

According to a study by Hewlett-Packard, a full 70 per cent of IoT devices are vulnerable to attack, with each containing an average of 25 separate vulnerabilities per product. In July 2015, it was revealed that a single software bug in the Android operating system made nearly one billion devices subject to hacking merely by sending them an infected SMS message. The security vulnerability, known as Stagefright, provides attackers access to all personal information on the phone, persistent tracking of its user and remote control of the device's microphone and video camera, as well as any photos or financial transactions processed by the device.

The fact that a billion of anything could be hacked with a simple text message should give us some perspective on just what becomes possible when billions of new IoT computers are connected to the global information grid. What if a similar flaw had affected a million cars, or pacemakers, or hundreds of power plants?

In 2016, fundamental IoT device insecurity means that there will be an ever-expanding "threat surface-area" for hackers to exploit. Nowhere are these effects more worrisome than when it comes to national critical infrastructure – bridges, tunnels, power plants, water-treatment facilities, hospitals, emergency services, financial markets and transport nowadays are all run by computers. The threat isn't just from state actors, such as the infamous Stuxnet worm that crippled the Iranian nuclear enrichment facility in Natanz; today the tools for attack are becoming commoditised. The growing interconnections between tradi-

tional information systems and the IoT mean cybercriminals can attack buildings, railway systems and chemical storage facilities. In Germany, hackers recently used a phishing email scam to infect the business information systems of a large national steel mill. Once inside the company's IT infrastructure, hackers wound their way into the firm's operational technology at the plant, causing an enormous blast furnace to overheat and explode.

When cybercrime goes 3D, bits and bytes can be manipulated to move atoms. In effect, our machines can be turned against us. Though we've wired the world, we've failed to secure it.

Of course, things needn't be this way. IoT security has been an afterthought – to say nothing of the draconian privacy implications of having all the things around us constantly reporting on our every movement, word and action. Individuals must take back control of their devices and demand more transparency from manufacturers. The time to think about our technological security is not after we connect 200 billion insecure new computers of all shapes and sizes to the internet, but before.

Security, safety and privacy must be engineered during the earliest phases of an object's development cycle, including its firmware, hardware and software. The cost of not doing so is simply too high for society. Ignore these important steps and the internet of things may prove to be nothing more than the internet of things to be hacked.

ROBOTIC RUMBLE

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Japan and the US will conduct a giant-robot battle in June 2016, Oaklandbased robotics company Megabots Inc's 4m-tall Mark II will fight Japanese counterpart Suidobashi Heavy Industry's Kuratas using water cannons and paintball guns. The teams may also add *mêlée*-situation weapons. GV





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FROM SMART DATA TO DRONE WARFARE



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BETTER DATA HAS THE POWER TO SAVE MORE LIVES

Data has empowered Google and Amazon. Now it's about to transform global development

By Melinda Gates

HERE'S WHAT EVERYBODY'S DOING ON A TYPICAL

evening in our house: my son Rory is listening to the Ed Sheeran station on Pandora; my daughter Phoebe is reading a John Green book that Amazon recommended to her; and I'm perusing my personalised newsfeed on *Flipboard*. These sites run on troves of data, and we rely on them to make our lives better, faster and cheaper. So I get frustrated sometimes because my field of global development isn't taking full advantage of the power of data.

Netflix knows what movies I like. Tesco knows exactly what needs restocking on its shelves and when. But in development, we still rely primarily on educated guesses. Luckily, we're getting better.

In the year 2000, every country in the world agreed on a list of 15-year objectives, the Millennium Development Goals, with specific targets – reducing child mortality by two-thirds, for example. In order to track progress and build on it, we needed data on how many people were dying and why. So countries started working harder to collect it.

Those 15 years are now up, and many of the goals have been reached, including the child mortality target. The next step is to adopt a further set of aims, and the United

MELINDA GATES

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Nations has just done that. But to meet the new Sustainable Development Goals we're going to need even better data, and more of it, which is where my prediction comes in.

The year 2016 will mark a sea change in how developing countries harness the true power of data to change their citizens' lives.

A couple of examples show how it will happen. First, family planning. Until recently, developing countries have tended to conduct national health surveys every five years or so. That means that in 2015, a government trying to give women the right kind of sex education and the right kind of contraceptives, in the right places, has to make assumptions based on data from 2010. But a new smartphone-based data system called Performance Monitoring and Accountability 2020 (PMA2020) has started giving governments a better version of this information every six to 12 months. In addition to collecting more data more frequently, PMA2020 also cuts in half the time it takes to analyse the data, so insights reach decision-makers faster.

Governments have begun to act on what they're learning. The Uganda Health Ministry, for example, found from its surveys that many of the country's younger people weren't using family-planning services. As a result, the government made reaching them a number-one priority in its national family-planning strategy. (And PMA2020 adjusted its survey to uncover the key misconceptions that prevented young people from using contraception.) Now, instead of waiting five years to find out whether and how that outreach is working, Ugandan leaders will know within a year.

Another example is women farmers. Women do around 50 per cent of the farming in developing countries. Although they work

MASTER OF THE WEB

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The US will cease to rule the internet. Some of the web's main functions are carried out by ICANN, a contractor of the US Department of Commerce. ICANN will become independent and will transfer those functions to a "global multi-stakeholder community" by October 2016. Gian Volpicelli

just as hard, and often harder, than men, they tend to get lower yields. We've never been able to figure out exactly why this is - until now, because the Women's Empowerment in Agriculture Index (WEAI) is finally giving us the answers we need. Women farmers in many different countries face a host of common obstacles - too little financial credit. not enough control over the money they earn and exclusion from social organisations, to name but three - but it turns out that the proportions of those obstacles are different in different places. The biggest single obstacle women farmers face in Liberia, for example, is that they have too little authority to make decisions about how they're going to farm. But in Nepal, it's that too many non-farming duties fall on their shoulders in addition to their already hard work of farming.

Based on the WEAI data, leaders in Bangladesh are running a pilot programme to find out which ways of working with Bangladeshi women farmers do the most good in certain areas of the country. This will benefit everybody, by the way; women aren't only farmers, they're also the carers of farming families. If they can grow more food and earn more money, they will invest in things like education and health that will in turn lead to a better future. The data will help start this cycle.

I know some people think data is boring. And obviously there are some ways in which global development still has a lot of catching up to do. Maybe my prediction for 2017 will be that development organisations will start coming up with better acronyms.

But you know what isn't boring? Saving people's lives. And the richer our troves of data, the more lives we can save.

2016 is when we're going to start getting it.

GOODBYE ROAMING CHARGES

The EU is ploughing on with its efforts to do away with mobile roaming charges in all its 28 member states. From April 2016, roaming fees in the EU will fall to 4p per minute of call, 1p per text and 4p per MB of data. The last step, in 2017, will be ending roaming charges altogether. GV

THE BLOCKCHAIN WILL BECOME OUR NEW SIGNATURE

Timestamped Bitcoin transactions can provide a path to data reliability

By Brian Forde & Michael Casey

BRIAN FORDE

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WHEN A BABY BOY WAS BORN ON AUGUST 4, 1961.

the local newspaper announced his birth, as it did many others. More than a declaration of happy news by his parents, those few lines of information were part of a long-lasting tradition – using the local daily to register, at a set point in time, the addition of a new person to society. Seemingly inconsequential timestamps like these occur every day and, as it turns out, play a key role in ensuring more fair and just societies.

It's not just limited to births. Kidnappers take photos of their hostages holding the front page of a recent newspaper to act as proof that they are still alive. Governments often require entrepreneurs to publish the establishment of their new company in a local newspaper. Beyond newspapers, a postmark confirms to a government that taxpayers filed their taxes on time. A patent helps inventors to prove to others that they developed an invention first.

But when we depend on private companies to manage this task, we have the potential for exposing ourselves to abuse. Manipulation of the chronological order – as when banks process a customer's largest cheque first rather than their most recent to increase the likelihood of it bouncing – creates a less just world.

Similar to the internet's facilitation of instant, global communication, a combination of time-stamped and digitally signed transactions hosted on a globally accessible ledger could play an important role. They could help governments

reduce friction and increase transparency associated with important transactions.

How might this be accomplished? Ironically, Bitcoin, an idea that was once thought to be anti-government, could end up a key platform for governments to achieve these goals.

In autumn 2008, Barack Obama was elected president, global financial markets were crashing and Satoshi Nakamoto issued a white paper called "Bitcoin: A Peer-to-Peer Electronic Cash System". This paper introduced the idea of a blockchain ledger, which the author intended to enable people to transfer money to each other without a bank.

Now entrepreneurs and developers are proposing other uses for this ledger, such as writing executable contracts without lawyers and automatically settling the transfer of stocks and bonds without a clearing house. They're building applications on top of the blockchain that could publicly and immutably record everything from the birth of a child to a transfer of property ownership. Timestamps, ledgers and digital signatures have been around for many years, but this combination has unlocked the opportunity for many new and consequential innovations.

With more than \$800m (£525m) in venture capital invested in digital currency-related startups over the last few years, the conversation around Bitcoin has shifted from curiosity, confusion and doubt to one in which serious decision-makers are recognising the many ways blockchain ledgers can be used. Bitcoin was initially thought of in narrow terms as an alternative currency to the dollar and other fiat currencies. Experts in other fields are now actively looking at how the blockchain can be used for non-monetary uses.

According to a 2013 report from McKinsey and Company, open data – freely accessible, machine-readable data provided by governments – can help unlock more than \$1.1 trillion in economic value in the US and \$2.6 trillion globally. Startups to the world's largest companies rely on open data to show home buyers crime on real-estate sites, help farmers perform precision farm-cropping or show parents the side effects of medicine for their sick children. However, other than weather and GPS data, it's generally only released once a year and is rarely responsive to citizens' input.

The blockchain could be a critical piece of infrastructure for governments to implement



what we call "responsive open data". Unlike today's open data, responsive open data responds to the commands of citizens – when they want it, where they want it.

By putting business licences, property titles or birth certificates on the blockchain, governments will enable citizens to digitally conduct transactions without lawyers, notaries or queuing at government offices. Once on the blockchain, registered ownership of a car, a home or other assets can be transferred from one person to another without the need for a government recorder or other third party, while still being legal and publicly acknowledged.

This is now possible because the blockchain is a public ledger of all previous transactions to which new transactions are added. As the blockchain grows, it becomes harder and harder to manipulate past transactions since the records of each are built on top of each other. This interdependence in the stacks of transactions gives permanent integrity to the recorded sequence of events and facts. It enables both the vital function of timestamping and, with the addition of digital signatures, the transfer of ownership without a third party like a government, bank or notary to confirm the transaction took place.

We're not the only ones thinking about this. The US state of Vermont is considering using the blockchain to track government records. Honduras is exploring the registration of property titles with the same technology.

DELIVERY BY DRONE

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The US Federal Aviation Administration plans to issue regulations for flying commercial drones by mid-2016. Currently, drones cannot be used for commercial activities - unless they are granted a waiver and fly within sight of the operator in daylight. Clear rules are awaited by companies such as Amazon, which wants to use UAVs for deliveries. GV



The pay-off: more confidence in the agencies that govern transactions and a chance to help secure a stronger foundation for just societies.

Like the internet, anyone can post anything to the blockchain, but the credibility and veracity of that information can be determined by whomever's digital signature was used to append that information. If the organisation or person signing the transaction into a blockchain-based record is trustworthy at the outset – that is, if there are sufficient checks and balances to show that the signature belongs to whom it claims to represent – the system can then offer a highly authoritative verification of any changes to it.

It's important to note that the integrity of the data must also be assured at the pre-block-chain stage. As the saying goes, garbage in, garbage out. Similarly, it's critical that transactions, contracts and documents are verified on a globally accessible public ledger – ensuring that the information stored on it cannot realistically be deleted or manipulated by any person, institution or government. Otherwise, in the hands of a bad government or actor, a poorly designed blockchain system could be abused, with drastic consequences.

If these data-integrity standards are adhered to, the blockchain could become a powerful tool for maintaining those records.

Challenges still exist to implementing this technology. Currently, Bitcoin has scalability limitations, requiring updates to its core code that are proving highly contentious among developers. Security concerns also persist. The oft-cited risk that hackers can steal bitcoins, though, hinges more on weaknesses with company security than the underlying core protocol itself. The same goes for the negative impression generated by some high-profile cases of illicit uses of bitcoins. Some criticism is valid, but much of it stems from past problems and lingering negative perceptions. Until sophisticated new protections for digital-wallet software and hardware have been properly stresstested in the real world and the digital currency gains more mainstream acceptance, many in the general public will mistrust it - and that makes it harder for governments to embrace.

Similar to the internet's vast, decentralised nature, finding information on the blockchain is difficult and connecting public keys to real-world individuals is challenging.



Both merit more research as developers compete to create tools and applications that work to address many of these issues.

Still, in the boardrooms and offices of some of the largest companies, not-for-profit institutions and government agencies, there's growing interest in Bitcoin's underlying technology. Whether it's adopted as is or adapted for special-use cases, the block-chain is thought to have enormous potential to disrupt the global economy and, we think, help support more open and fair societies.

In that spirit, the MIT Digital Currency Initiative is working with entrepreneurs, open-source developers, philanthropists, non-government organisations, academic institutions and, of course, governments to conduct fundamental research and develop practical pilots to identify where the block-chain could bring real improvements to society. Building on the work of many software developers, academics and entrepreneurs, below we lay out several examples worthy of exploration. Research and experimentation in these areas could help us get to the future, faster – something we think companies and citizens should demand from their governments.

BIRTH AND DEATH CERTIFICATES

Much of what we do in life stems from being able to prove we were born on a certain date under a certain name to an identifiable mother.



GENDER Balance

Germany has introduced a law requiring that corporations ensure that at least 30 per cent of their non-executive board seats are occupied by women, starting in January 2016. France had passed similar legislation in 2011 - establishing a more ambitious quota of 40 per cent - with the end of 2016 being the deadline for public companies' compliance, GV

Documentation of our birth and the date on which it occurred confers a right to vote, a right to open a bank account, or a right to obtain a passport and travel. For the purposes of inclusion in the global economy, it's hard to imagine a more important record-keeping task. Yet the mismanagement of such records is rife worldwide. Up to a third of children under the age of five have not been issued a birth certificate. According to UNESCO research, a lack of formal citizenship status and ID is the single greatest risk factor contributing to the trafficking of girls in places like Thailand.

The blockchain could be used by governments or other locally trusted institutions to issue birth certificates and death certificates. When encoded with encryption methods that give people personal control over such data, it will not only make the record-keeping more reliable but could also empower citizens to access critical services. People could point government agencies or service providers to a digital record of their birth, or to a family member's digital death certificate. Taxpayers would also benefit, reducing the problem of governments continuing to pay social welfare or other benefits to deceased people.

BUSINESS LICENCES

Civic-tech entrepreneurs Chris Taggart and Rob McKinnon launched OpenCorporates just over four years ago with the goal of cataloguing every company in the world and entering them into its open database. After thousands of hours spent culling through millions of original records, they have laboriously constructed a useful cache of information covering some 90 million companies. It did a great service, but in a globalised economy we need a more seamless, automatic way to gain access to all these data.

It doesn't help that these business records lackinternational standards. Some government agencies publish business-licence information in an easily accessible machine-readable format. Others publish it in a more challenging to access PDF format. Many also require publication in local newspapers to complete the process of registering a company.

Enter the blockchain. Adopting a responsive open-data strategy, governments could leverage the record-keeping reliability of the blockchain to register businesses in a quick and efficient manner. The interoperability of the



THORIUM POWER

India's Department of Atomic Energy plans to complete the world's first thorium-based heavy water nuclear reactor in 2016. Producing energy from thorium - a uranium isotope is challenging, but India is investing as it has little uranium and one of the largest thorium reserves in the world. India's goal is to use thorium power to produce 25 per cent of its energy by 2050, GV

blockchain means that disparately maintained registries in different jurisdictions could be combined without people like Taggart and McKinnon having to do their laborious work. Not only would entrepreneurs benefit from the efficiency of the technology, but the blockchain's timestamping powers could slash the amount of work civil servants spend tracking down lost documents, reconciling records and generally maintaining the databases.

PROPERTY TITLES

People's homes are most often their biggest asset – something that can be borrowed against to start a business or secure a safe retirement. In the developing world, property titles take on even more meaning. Peruvian economist Hernando de Soto, for example, has identified trillions of dollars of "dead capital" in the developing world: people living in the world's poorest slums own their homes, but without formal titles they can't easily sell, appraise, insure or borrow against those assets.

Here, too, the timestamped power of the blockchain could help. Using this decentralised ledger to keep track of the many transactions that accumulate over time with a specific land deed could greatly reduce both the costs and headaches associated with managing them. The blockchain's interoperability should also mean that these benefits can be carried across borders so that data from different land registries apply across geographic zones.

The blockchain can only do so much. It can't get around the deep political failings and corruption that leave certifying authorities unable or unwilling to do the work needed to survey, define and draft titles. But if officials can be persuaded to start the process, each phase can be recorded in the blockchain. This could make it possible to verify that appropriate steps were taken in the right sequence. Once the title itself is registered on the blockchain, locals could, for the first time ever, have verifiable ownership of a valuable piece of collateral.

Governments who shift their land title registries to a blockchain-based system could lay the foundation for more fair and transparent land-ownership transactions in the future. Furthermore, these records would be more resilient during times of conflict or state collapse when such legal documents are more likely to be destroyed or tampered with.

NON-GOVERNMENT RECORDS

This model need not apply solely to government record-keepers. A similar opportunity exists for universities to use blockchain record-keeping for college transcripts.

In Pakistan, Kenya and other countries, government leaders have been required to have university degrees to hold office. This has generated headlines from "[Kenyan] Leaders warned on use of fake degrees" to "Over 100 MPs in Pakistan may have fake degrees."

Confirming a person's educational credentials can be laborious. To improve this process, universities – and even secondary schools – could store transcripts on a universal, decentralised ledger. This could bring greater transparency to the assertions people make about their educational records and make it easier for students to selectively share their scores with educational tech companies for customised tutoring or support.

There are no easy fixes for any of these problems, and we must stress that Bitcoin and blockchain technology are largely untested for the use cases we describe. But as an academic research initiative, we are exploring options and identifying innovations that have the potential for impact. That way, when solutions are finally implemented, they serve society in the best possible way.

What's clear is that the existing system of government and institutional registries could be updated to address the needs and challenges of our digital age. By implementing responsive open data via the blockchain, we now have an opportunity to do that.

Five decades later, that August 1961 announcement in the local daily newspaper, the *Honolulu Advertiser*, served a useful purpose. It allowed Barack Obama to point to a timestamp reinforcing the authenticity of his birth certificate – and helped ensure he became the 44th President of the United States.

But for the rest of us, digging into the microfiche of old newspapers to verify transactions just doesn't scale. The Bitcoin blockchain and its timestamping and peer-to-peer transaction system could be the answer, providing a path to data reliability and interoperability. With it, we could empower citizens and boost their confidence in the agencies that govern their lives. In memory of Jake Brewer and the tireless work he did advancing open data throughout his life.

DRONE SWARMS WILL CHANGE THE FACE OF MODERN WARFARE

Prepare to see flocks of self-flying UAVs operating as a battle unit

By David Hambling



DAVID HAMBLING

is a Londonbased freelance journalist and author. His latest book, *The Dulwich Horror* & *Others* (PS), was published in September 2015

THE SUMMER OF 2016 WILL MARK A SIGNIFICANT

moment in the future of air warfare: swarms of US Navy robots will leave the laboratory and be tested in the field. In the past, small numbers of extremely expensive manned aircraft were the norm, but, in the next few years, large numbers of cheap, expendable drones will be deployed in real-world situations. The US Navy's Low-Cost UAV Swarming Technology (LOCUST) programme is fusing unmanned aircraft into a swarm, and will demonstrate 30 drones flying together somewhere over the ocean.

The challenge won't be just getting them in the air at the same time – what makes a group into a swarm is its ability to co-ordinate. "A swarm operates as a unit," says Stephen Crampton, CEO of Swarm Systems, an autonomous-systems startup based in Hertfordshire. "It has a mission that it has to carry out, and it is self-reconfiguring so that if one drone gets taken out, the others autonomously change their behaviour to complete the mission."

Any aircraft, manned or unmanned, can be brought down by a single missile, but a swarm can take multiple hits and keep going.



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THE POWER OF PROTECTION

Being able to absorb this type of damage makes the drone swarm hard to stop, especially when defences are geared towards shooting down single planes. Designing a system in which drones are aware of each others' movements is a significant breakthrough.

"It is the communication and/or awareness of each other that represents the major leap forward from remotely controlled and independent platforms to those that allow for collaborative behaviour," explains Lee Mastroianni, project manager of LOCUST. The programme has been working with the Georgia Tech Research Institute to develop a system in which individual drones will position themselves autonomously, flying in formation without being told explicitly where to go.

"Precise formation control of large numbers of UAVs while conducting various manoeuvres is a major demonstration objective," says Mastroianni. Managing the swarm requires a new approach to control: instead of remotely piloting a single drone, the operator manages the swarm. He describes how the operator's interface will handle "aggregation" and "disaggregation", his terms for drones joining or leaving the swarm. A single drone might detach to get a closer look at a target, and return or carry out an attack.

The main hardware for LOCUST is the Coyote drone, a metre-long unmanned aircraft produced by defence manufacturer Raytheon. Coyote was originally designed as an expendable reconnaissance asset with folding wings, so that it can be fired from the tubes used for dropping sonar buoys on anti-submarine aircraft. Once clear of its launch tube, the Coyote's wings flick out and it can fly for up to 90 minutes on battery power, beaming back video from 30 kilometres away.

TRIDENT DECISION TO BE MADE

The UK Parliament has until March 2016 to decide whether to renew its Trident nuclear programme. The plan is to replace submarines with newer crafts built by BAE Systems. Labour leader Jeremy Corbyn's anti-nuclear sentiment could, however, slow down the decision process. GV

But the hardware is less important than the sensors and software enabling the drones to act in a swarm. "I am largely UAV agnostic," Mastroianni says. "The key is a modular UAV that can easily accept different payloads depending on which missions are desired and can be produced cheaply enough that they are one-way."

Adaptability is important because different payloads are required for different types of mission: the drones may be equipped with video cameras or other sensors, jammers to interfere with enemy radar or they might carry explosive warheads for *kamikaze*-style attacks. This is why "low cost" is part of the name – the drones must be cheap enough to be expendable. "Reaching the point where an entire swarm of UAVs costs less than a single missile is the general objective," Mastroianni says. The goal seems realistic enough when you consider that the US Navy's Harpoon anti-ship missiles cost around \$1.2 million (£770,000) each.



Offensively, the swarm can overwhelm conventional adversaries: anti-aircraft batteries simply don't have enough missiles to stop them. And although the Coyote drones may be too small to sink a ship on their own, they could potentially knock out radar, missile launchers or other key systems, leaving them vulnerable to other attacks. In defensive mode, a swarm can form a protective cordon against fleets of fast boats like those used by Iran's Revolutionary Guard. The swarm might carry out high-risk reconnaissance missions, collecting imagery or other sensor data from targets too well-defended for a Predator drone or a manned aircraft to approach.

Mastroianni says the biggest challenges for the swarm are not technical, but more based on perception: safety policies treat unmanned aircraft as if they are manned, meaning that they are highly regulated. And there is the added complication that the drones are largely autonomous rather than being individually





NEW GOALS

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FIFA will elect a new president on February 26. Sepp Blatter, who has been holding the post since 1998, announced in June 2015 that he would resign, following a US investigation into FIFA's alleged involvement in bribery and money laundering, **GV** remotely piloted, so they are not under human control at all times, like current drones, which makes policymakers cautious.

"Establishing trust in autonomous UAV systems is not only the biggest challenge, but a major objective," Mastroianni says. Swarms at sea are a start, but the real impact will be when they engage in land warfare. Stephen Crampton, CEO of Swarm Systems, says the cluttered tactical environment where drones have to avoid trees, buildings and power lines is far more difficult than open water. Autonomous sense-and-avoid for small drones is still in its early stages, but as processors get more powerful, these systems are becoming faster and more reliable. Crampton says that other advances such as deep learning and neural networks also offer potential solutions and the technology is advancing rapidly.

Swarm Systems demonstrated a swarm of quadrotors at a Grand Challenge event for the Ministry of Defence in 2008. But the first step into the market is an individually-piloted drone called Nano - Crampton compares it to "flying binoculars". "When you've got a squad that is pinned down and can't see, they need flying binoculars, which they can send over the hill or around the corner," he says

British soldiers already have Black Hornet, a palm-sized helicopter with cameras, but it is useless in strong winds; Crampton claims the Nano will be able to fly 99 per cent of the time. The company's background makes the Nano a first step towards tactical swarms of many drones working together. "You can see soldiers having a peripheral reconnaissance swarm," Crampton says.

Battery life is a big issue for small drones. But a swarm can have a "hive", a base station where individual drones return for recharging while the rest continue their mission. To the operator, unaware of charging going on in the background, the swarm's endurance is unlimited. This approach is relatively easy for fixed bases; Crampton says a mobile hive for soldiers on patrol is more challenging. A walking robot such as Boston Dynamics' BigDog, however, offers a good starting point.

Next year will be a breakthrough year for drone swarms – once trust in swarms is established, development is likely to be rapid. Then Crampton's "peripheral reconnaissance swarm" will change the face of the battlefield forever – especially when the drones are armed.

REPUBLICANS TO TAKE A LEAF OUT OF OBAMA'S BOOK

Aaron Ginn will help the Grand Old Party use tech in its election bid

By Oliver Franklin-Wallis & Madhumita Venkataramanan

IN THE 2012 US PRESIDENTIAL ELECTION, BARACK

Obama stormed to a second term. Among the reasons for his victory: his campaign's groundbreaking use of technology - from social media to data analytics - to mobilise supporters. Now, with the 2016 election looming, the Republican Party is hoping to learn from its rival, with the help of entrepreneur Aaron Ginn. "We're trying to replace the notion that everyone in Silicon Valley is left-wing," says Ginn, co-founder of San Francisco-based Lincoln Labs. Formerly head of growth at StumbleUpon, he helped launch the startup in 2013 to introduce the Grand Old Party to software engineers through a nationwide series of hackathons. At the company's first annual Reboot conference in July, for example, Republican 2016 presidential hopeful Rand Paul mixed with startup founders and venture capitalists, creating apps for online voting and campaign donations between keynotes.

"We had a guy who created an app that overlaid crime-reporting data with police scanner data, so when you combine the two you see areas that are being underserved. It's more of a public service," Ginn says. "For 2016, Lincoln Labs is going to focus on becoming the bridge between the tech world and the political world." In the run-up to the 2016 election, the startup will host a series of events called Disrupting Democracy – an opportunity for the technology community to publicly ask questions to the presidential candidates – which kicked off with Senator Rand Paul in May 2015.

Away from his work for Lincoln Labs, Ginn is a personal political adviser to Republican candidates at state and national levels. "I can't disclose the specific campaigns I am working with until after things flush out in the primary," he says. But his strategy is clear: he uses a data-led approach to wooing voters. "In politics, the core product is the candidate. Your goal is to make people fall in love with your product faster," he says. "So we work on things like: how do we motivate people to move from a smaller to a larger donation? How do we make it easier for them to register?"

From 2016 onwards, Ginn argues, elections will increasingly be won not by trail-hardened campaign managers, but by analysts making decisions based on real-time data, such as how to personalise messages to diverse voters. "Having technology at the core of the decision-making team is the next version of the political campaign," he says.

But can tech alone stop Hillary Clinton? "You can't growth-hack a candidate who isn't working with voters," Ginn admits, conceding that the Republicans still have some way to catch up. "If we just copy what Obama did in 2012, we will lose."

DATA PROTECTION OVERHAUL

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The European Commission is aiming for an EU-wide adoption of the new General Data Protection Regulation by the end of 2016.

Companies failing to keep data private, or which are involved in data breaches, will have to pay penalties of up to two per cent of turnover. GV

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PEOPLE WILL FINALLY FALL IN LOVE WITH RENEWABLE ENERGY

Towering turbines and giant batteries will begin to win hearts and minds

By Ben Hammersley

BY 2020, A EUROPEAN COUNTRY'S ELECTRICITY

supply will run, for one week, on nothing but renewable energy. In 2016, several significant milestones will take place to make this happen. Consider energy production, one of our biggest challenges. A growing population, more electronics and climate change driving a need to leave fossil fuels behind means that we'll have to generate more and more electricity, using more and more renewable methods. There are two primary ways to do this in Europe: wind power and solar power.

Until this decade, though, both of these methods have been less successful than we'd hoped. Solar panels, although improving, aren't very efficient – which is bad in a cloudy continent such as Europe – and wind turbines tend to split popular opinion right down the middle. Some consider them awesomely beautiful, whereas others see them as a blight, a danger to wildlife and a con. General public opinion would prefer to have a polluting coal-fired power station somewhere over the horizon than windmills in plain view. And no one wants to use less power.

You might think that this is social problem, one of attitude change rather than technology. But Denmark found a solution by putting its wind farms offshore for stronger winds and fewer objections. The Danes now dominate the industry. No surprise, then, that during 2014, just under 40 per cent of all Denmark's electricity was generated from wind power. There were even some days when the country's entire electricity demand was sated by offshore turbines. From 24 hours at a time now, to a week at a time in a few years, seems entirely possible.

But those peak events do point out a disadvantage with wind power: its variability. Just

HAMMERSLEY

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as solar doesn't work at night, the wind doesn't always blow. We'll need to have a mix of generating technologies to get us through the dark and still times. Which leads us to the second big idea: by 2050, Denmark plans on having all of its energy needs – vehicles and factories included – delivered by renewable sources.

So how to do this? The answer is probably already in your pocket: batteries. In 2014, the race began to bring new, giant, household-sized battery technology to the market. At the end of April 2015, Tesla introduced the Powerwall: a massive battery you can mount on the wall of your home, hook up to solar panels to charge during the day and use to power your home the whole time. This load shifting concept, and the idea of using it to disconnect entirely from the grid, has caught on: a month after launch, Tesla had reportedly more than \$800 million (£500m) of pre-orders.

Meanwhile, by the end of 2016, Facebook's new data centre will open in Fort Worth, Texas. That's a very warm city to be building such a facility – data centres need to be kept cold – but Facebook says that it's, ahem, cool with the plan. The whole building, servers and coolers and routers and everything, will be powered entirely and solely from the accompanying 200MW wind farm it is building next door. What's more, it is giving the plans away, so other builders of large energy-intensive data centres can do the same thing. The usual thinking about energy production is being, yes, blown away.



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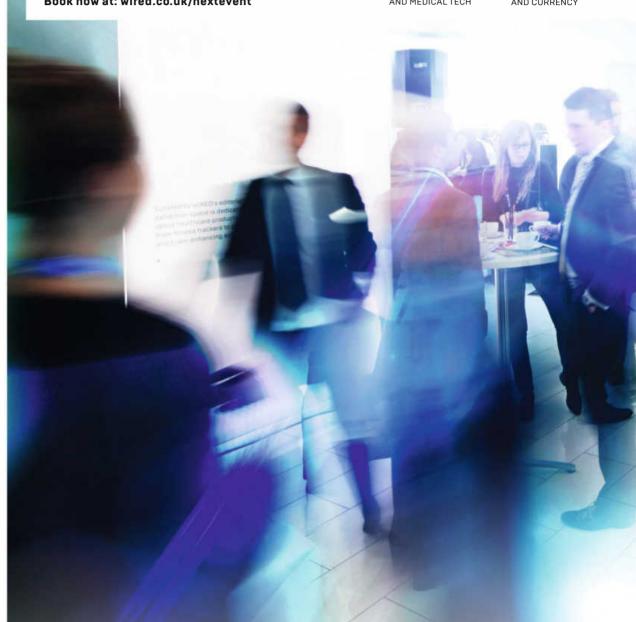




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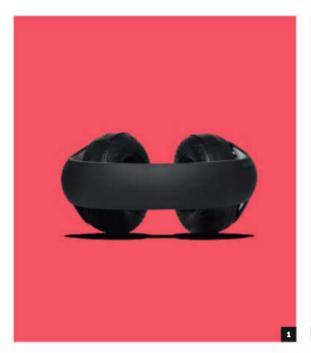
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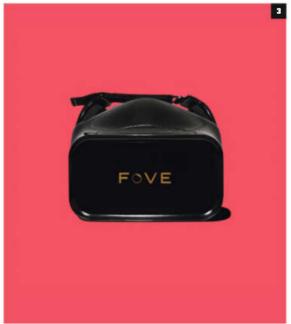


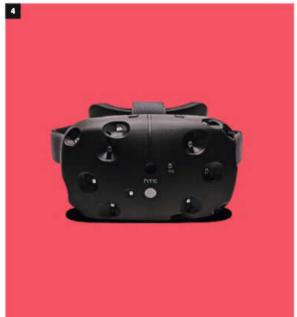
PLAYSTATION VR

Sony's slick VR headset has received an upgrade: it now boasts a bright 5.7-inch OLED display to rival that of the Oculus Rift, and has graphics running at a blistering 120 frames per second, besting the 90fps of the HTC Vive. The number of LEDs used to monitor head movement has also risen from six to nine, to improve the accuracy of the 360° tracking from a PS4 camera. Image latency has been all but eliminated, resulting in a nausea-free experience. Due first half of 2016. £tbc playstation.com









VR HEADSETS

1. Avegant Glyph – the Glyph uses micro mirrors to beam images directly on to the wearer's retina. Due early 2016. \$600 avegant.com
2. Oculus Rift – this Facebook-owned VR flagship pushes a huge 233 million pixels per second. Due early 2016. £tbc oculus.com

3. FOVE – the only headset to combine VR with real-time eye-tracking for more realistic interactions. Due May 2016. £tbc getfove.com
4. HTC Vive – a SteamVR-powered, 1,200 x 1,080-pixel, 90fps headset with a gaming focus. Due early 2016, £tbc htcvr.com



ROLL TO ROLL HEADPHONES

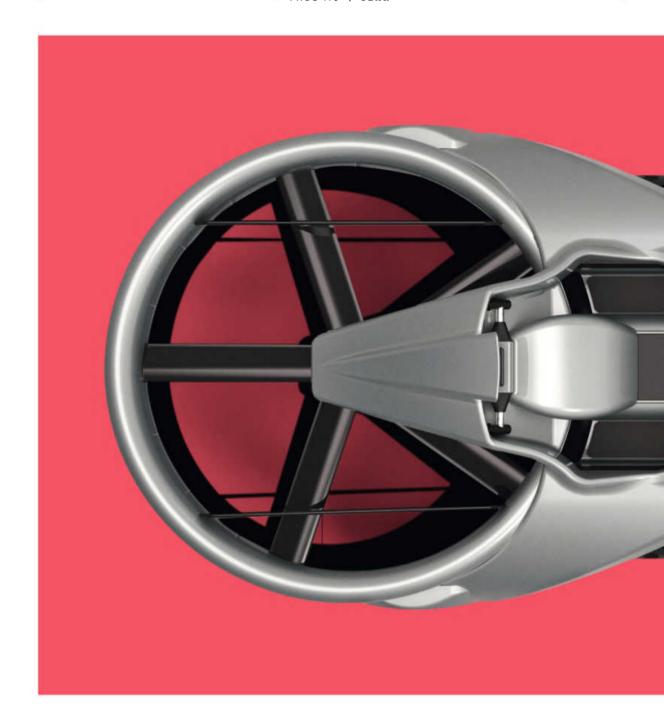
Maxime Loiseau's minimalist headphones are super-slim, comprising just eight elements for each earpiece (Beats headphones, by comparison, have 50 parts). Fiddly wires have been removed and replaced with printed circuits. Cavernous earpieces, meanwhile, make way for 1mm-thick piezoelectric cells which vibrate on a plastic surface to create sound. £tbc maximeloiseau.com



PHOTOGRAPHY: MITCH PAYNE

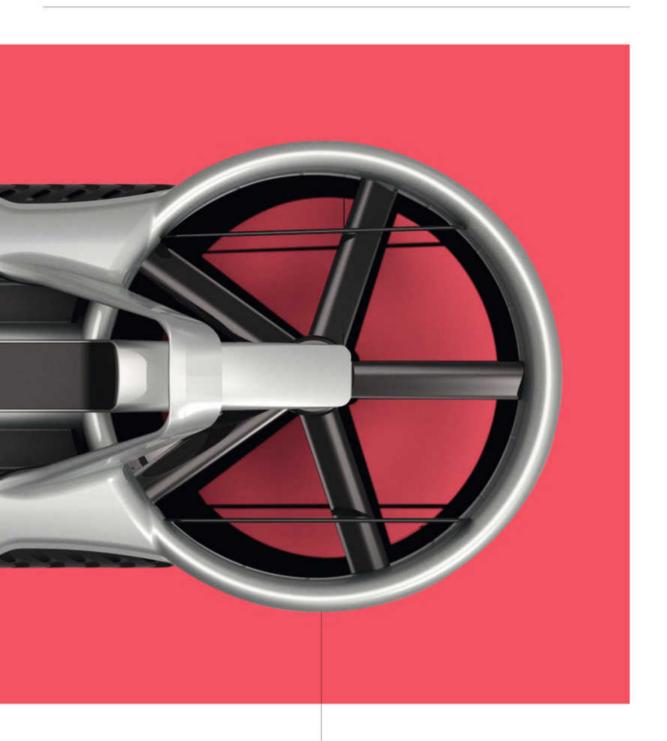
AUDI PROLOGUE/A8

The Prologue is no flight of fancy – elements from this concept will appear in imminent road models. The new A8 is due out in 2016 and should include features such as the Prologue's dashboard-width touchscreen display. Meanwhile, a "digital butler" will recognise occupants by their smartphones, and make comfort-setting adjustments to match. Audi A8 due in 2016 £tbc audi.com



AEROFEX AERO-X

The 4.5m long, 2.1m wide Aero-X hoverbike can whisk two people (with a combined maximum weight of 140kg) at a height of 3m above the ground, at speeds of up to 72kph. Fixed-pitch carbon-fibre rotors allow the Aero-X to take off and land vertically, and a full tank of petrol should keep it in the air for up to 75 minutes. Test flights due to begin in 2016. \$85,000 aerofex.com



Extras include whole-vehicle airbags and flotation pontoons for safer flying over water



KEECKER

This cute, egg-shaped robot is the brainchild of Pierre Lebeau, a former project manager for Google, who's now based in Paris.

KEECKER scoots around your house – making a map so it doesn't bump into anything – and then helps you in taking calls, projecting media on to walls, or acting as a roving security and environmental monitor. Due April 2016 \$4,000 keecker.com



DFM01 OUSIA

Japanese design studio Triple Bottom Line has created what it claims is the world's first viable 3D-printed road bike.

The prototype DFM01's head, seat cluster and entire bottom section are printed from titanium, via selective laser sintering. Its top, bottom tube and seatstays are made from carbon-fibre tubing. Approx \$6,000 (frame only) www.triplebottomline.cc



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FROM EDUCATION NETWORKS TO RELATIONAL CAPITAL



BUSINESS

FEATURING WRITING BY
REID HOFFMAN
MADHUMITA VENKATARAMANAN
RORY SUTHERLAND
NATALIE MASSENET

ILLUSTRATION: Sam Chivers

SPOT ILLUSTRATION:



SOCIAL NETWORKS WILL HELP EDUCATION TO REALISE ITS TRUE POTENTIAL

The growth of online platforms means learning will be next to connect

By Reid Hoffman

FACEBOOK AND LINKEDIN HAVE BEEN AROUND

for more than a decade. Twitter is almost as old. In 2015, social networks are so all-encompassing it's hard to imagine how we ever lived without them. Similarly, it's easy to imagine that the ones we currently use are enough. How many different places do you really need to present your digital self to the world – especially when that self is built around your actual name in most instances? Three? Five? Ten?

Obviously, it varies for each individual. But there are still major networks to create. So, I predict that, in 2016, we will see at least one education network go mainstream.

The central reason why: education is a realm where people maintain unique identities and relationships, and optimal outcomes are key to one's overall quality of life. As such, it can benefit from the efficiencies, amplifications and accelerations that networks create.

To fully appreciate the value an education network can unleash, just think about the critical role that more general networks already play in how we identify important new ideas and innovations, and spread them faster. Ten-plus years ago, the key competitive edge to winning in business involved accessing information more efficiently than one's competitors. Those who did this were better

REID HOFFMAN

is co-founder and executive chairman of LinkedIn



informed, had more context, and could see more clearly where things were heading.

Today, all this holds true. But how you achieve this competitive edge has shifted. We've entered what I call the Networked Age: an era where *what* you know – information – is framed by *who* you know – relationships.

In the Networked Age, our friends and colleagues find and filter information that is most useful to us. Networks create tighter feedback loops. They surface and accelerate what's most relevant to know. They make it possible to engage in extremely high numbers of interactions and transactions, in part by aggregating and redistributing trust. You may not know the eBay seller who is promising you an item, but you do know that 479 other buyers in eBay's marketplace have rated that seller favourably, so you proceed with the transaction.

With networks, we can navigate all the options and opportunities that might otherwise overwhelm us – they're the keys to clarity, purpose and success in an always-on world of infinite data and possibilities.

I'm keen on the idea of many networks, because, ultimately, people are complex, with many different facets. We engage in a variety of pursuits, in a variety of environments, and often the relationships we maintain in these environments are unique to that realm.

One way to get a sense of how many identities people maintain is to simply look in their wardrobes. We have different clothing for different facets of our identity and different modes of behaviour. You can think about social networks as digital clothing. They're what we "wear" to present different versions of ourselves online, as we engage in different pursuits.

Of course, many of these networks aspire to be the shirt you can wear anywhere. But there is still a significant need and a demand for much more targeted networks and platforms. Although you might be able to pull off a high backhand volley in a tuxedo, you're likely to perform much better in a tennis shirt – it offers physical abilities a tuxedo can't in that context.

Networks are the same: general-purpose networks are obviously valuable, but there's

BOOM-TIME FOR MOBILE ADS

-

Spending on mobile adverts aimed at smartphone and tablet users is expected to hit \$100bn worldwide in 2016, according to a report by eMarketer. US spending on mobile advertising will be double 2014's, while China's will treble. Gian Volpicelli

a growing role for more specialised ones. In 2005, we hit one billion global internet users, a benchmark that helped usher in the era of social networks. Just ten years later, we're at more than three billion global users, many of whom access the internet via phones and tablets.

In other words, more people are using the internet more often, in more places than they were ten years ago. That's creating an opportunity for a whole new generation of networks that cater to various aspects of personal identity and the relationships associated with them.

Roughly speaking, Facebook is where you maintain personal relationships. My company LinkedIn is for your professional life. Twitter is for what's happening now. Pinterest, Tumblr, YouTube and *Instagram* are venues for sharing your creativity.

These are generalisations and there's overlap in many of these networks - they can be used personally and professionally - but they're all fairly broad and flexible, and in part that's why I think there's so much growth left. Magazines didn't stop at *Time* or *Life*. Television didn't stop at the BBC and ITV. In the cable era, we saw the rise of hundreds of "specialised" channels that can still reach hundreds of millions of people.

Over the next decade, we'll see a similar trajectory play out with platforms that are explicitly built around networks. That's why I've made many investments, professionally and personally, in for-profit ventures and non-profits that are network-oriented. NextDoor, for example, where I serve on the board, is built around a person's identity as a member of a specific geographic community. Edmodo, where I'm also a board member, is an education-oriented network that caters to people's identities as teachers, students

and parents of students. I was involved in the first round of funding for Change.org, which is a network where people establish and maintain their identities as participants in civil society. Kiva.org (again, I'm a board member) is a micro-finance network where lenders provide zero-interest loans to entrepreneurs all around the world.

My prediction for 2016: an education network will break out in a big way. In the Networked Age, technologies shift overnight. Opportunities span the globe, but so does competition. As I wrote in my book The Start-up of You, individuals must cultivate an adaptive, entrepreneurial, "permanent beta" mindset to survive. Education is the key to success - starting at the K-12 level (pre-school to year 13 in the UK) and continuing throughout one's life. In developing countries, this dynamic is even more pronounced - smartphones are often the only device for knowledge acquisition, and the opportunities that online education creates can be life changing.

The more people recognise that education equates to prosperity and security in the Networked Age, the more they'll recognise the importance of using networks to enhance their educational efforts. Think about the current landscape. Schools have spent billions investing in laptops and tablets for their students. Thousands of content creators are producing courseware, ebooks, video, study apps and tools. As platforms such as Khan Academy, Udacity, Coursera, AltSchool and Lynda.com (which LinkedIn acquired for \$1.5 billion in April) come online, the opportunities to pursue education at all stages of life from kindergarten through to adulthood - are becoming more ubiquitous and more flexible.

To utilise these abundant resources most effectively, it helps to have a network of trusted peers and allies providing context, recommendations and other kinds of information and feedback, collectively and in real-time. Ultimately, education is a highly social activity. Humans learn by modelling the behaviour and internalising the experiences of others. When people learn in social settings, even asynchronously, they retain information better. With networks, learners can exponentially increase the number of students they talk to and observe, and that's why they make so much sense in educational settings.

POWER ON DEMAND

Electric car maker Tesla is planning to open its first lithium-ion battery factory in Nevada. Dubbed Gigafactory 1, the \$5bn facility is expected to reduce Tesla's reliance on Panasonic as sole supplier of batteries for its vehicles - though Panasonic itself will have a stake in the project. GV



Also critical is the fact that education is a realm where people have very distinct identities and relationships that they'd like to maintain apart from other aspects of their lives. For example, if you're a student, your Facebook friends probably include fellow classmates – but not your teachers or your principal. If you're a parent, your Facebook friends may include a couple of other parents whose children go to the same schools yours do – but only a couple.

And even then you may not consider Facebook the most appropriate domain to engage in an in-depth way about specific and confidential school-related issues. Education, in short, is a domain where a more topic-specific network can deliver much more value than a general-interest one.

An education network gives students a focused venue where they can discuss homework assignments and find tools and materials that can help them on specific subjects. It gives teachers a place to share recommendations about new courseware. It allows parents to follow what their children are learning on a more informed basis.

Education networks also make physical classrooms both more intra-connected and more extensible. Students in the same physical class can work collaboratively inside and outside the classroom, but these networks also allow students to find resources and peers outside of their own physical class who are studying the same topics or working to overcome the same challenges.

Any classroom that is simply using its connectivity to allow students to all watch the same video simultaneously, or to all log in and participate in the same massive open online course at the same time each day, is only scratching the surface of what computers and networks can actually provide in an educational setting.

To get the most out of a highly connected, digitised world, you need platforms that emphasise personal interconnectivity. The success of platforms as varied as Facebook, LinkedIn, Twitter, eBay, Uber, Dropbox and Airbnb has shown how networks can increase, amplify and accelerate positive outcomes of all kinds. In 2016, I believe the education world will embrace this fundamental lesson – let's call it Networks 101 – and matriculate to the Networked Age.



BEACONS WILL LEAD US TO BARGAINS

By connecting to our smartphones, our favourite shops will change how we navigate the high street

By Madhumita Venkataramanan

MADHUMITA VENKATARA-MANAN

is head of technology at Telegraph Media Group



TAKE A STROLL DOWN THE ONE-KILOMETRE-LONG

shopping strip of Regent Street in London, and more than 100 of its flagship stores – from Banana Republic to Gap, Hamleys and Burberry – will be silently pinging your smartphone as you walk past.

If you download the *Regent Street* shopping app (iPhone only, for now), these Bluetooth-enabled pings will pop up as messages with targeted deals, discounts and promotions – just because you happen to be in the neighbourhood. As WIRED walked by, we received a reminder for a Banana Republic sale and an offer to win a Mappin & Webb necklace.

The Regent Street stores are using beacons to communicate – tiny, low-energy chips housed in a discreet plastic case, which can beam data out to your smartphone, based on Bluetooth positioning. (For those worried about potential privacy infringement, these devices can't receive or store anything in return, and an opt-in companion app is usually needed to push notifications to you.) These sensors are the real-world equivalent of pop-up online ads that target our specific interests based on the websites we visit, and so link the two worlds.

When Regent Street launched a beacon programme for 120 stores in summer 2014, it was the first full shopping route in Europe to trial the technology on a large scale. "Integrating mobile and online platforms with physical retailing provides the kind of tactile experience shoppers value," says Bob Dawson, head of asset management for The Crown Estate's Regent Street portfolio. "We are taking a leading role in this globally." In the US, more than 30 per cent of the top 100 retailers, including American Eagle Outfitters, Macy's and Urban Outfitters, had already deployed beacons in-store, and another 20 per cent were trialling them in 2014. Research from information service BI Intelligence projects that this figure will rise to 85 per cent by the end of 2016. It also predicts that beacons are expected to directly influence \$4 billion (£2.5 billion)



PLANET NETFLIX

Streaming firm Netflix has announced to its investors that it plans to operate in 200 countries by the end of 2016, kick-starting its enlargement early that year with South Korea, Singapore, Hong Kong and Taiwan. Given that Netflix was accessible in 77 countries as of September 2015, reaching the stated goal requires adding a country every two weeks. GV

worth of sales in the US in 2015, and potentially increase by tenfold by the end of 2016.

San Francisco-based startup Shopkick is both a hardware and software business in this growing sector – it produces beacon chips as well as a dedicated shopping app. "Our beacons stick to a wall and have a battery life of five years, and can send out about ten signals per second," says Cyriac Roeding, founder and CEO of Shopkick. "Apple's iBeacon technology is the format of how you send messages via a beacon." iBeacon, which Apple rolled out in November 2013, allows alerts to be sent via beacon to any smartphone, not just iOS, and can be targeted precisely to specific areas of a store, such as the tills or changing rooms.

Shopkick, acquired for over \$200m last September by South Korean corporate giant SK Planet, has built one of the largest beacon networks in the retail world, and has 14 million app downloads, according to Roeding. "We launched in 2010, and are now live with 14,000 retailers in the US, Germany and South Korea," he says. "In 2016, we are going into a massive roll-out phase in Europe and Asia, as well as the US." The startup, which works with 200 brands including Procter & Gamble, Disney, Sony and Unilever, announced in late 2014 that sales by brick-and-mortar businesses using the Shopkick mobile app. shopBeacon, exceeded \$1 billion. "We have clear data from third-party research studies that show Shopkick drives between 50 to 100 per cent more store visits once we offer a reward for visiting," Roeding says.

And it's not just startups that are jumping on to the mobile-ad targeting bandwagon: in 2015, Facebook and Twitter both stepped in. Facebook gave out free beacons to all US stores willing to trial Place Tips, a new Facebook feature which shows its users posts and photos about a specific retailer or business when they open Facebook on their smartphone, when in the actual store. Twitter participated in an \$18m funding round for Boston-based beacon marketing startup Swirl, which has beacons installed in stores such as Lord & Taylor and Timberland.

"In 2016, every significant retailer will install beacons if they want to be a player globally, because it bridges the online and offline worlds," says Roeding. "We are going from the phase of roll-out to requirement."

BITCOIN TRADE WAR

experience a schism. As the number of users has ballooned, some developers have suggested the whole community shift to an updated Bitcoin software – Bitcoin XT – which is able to process more transactions. But many users disagree, loth to tamper with the original Bitcoin project. A showdown is expected to happen in January 2016 when – if three quarters of Bitcoin operators choose to switch to XT – users of the two

versions will be unable to trade. GV

Cryptocurrency bitcoin might

ONE OF THE MANY ASPECTS OF UBER WHICH

often surprises people is that not only does the passenger rate the driver, but the driver also rates the passenger. Recently, I was surprised to learn from an Uber driver that my own current passenger rating (4.9 out of 5) is, in the eyes of the driver, "better than a 5.0".

I asked him why. "Because it shows you have used Uber a lot," he explained. "Someone with a 5.0 may be completely new – and have a 5.0 rating by default. Or they may have only made one journey. Anyone can manage not to be an arsehole on one journey. If you've made 50 journeys and only been a little bit of an arsehole once, that makes you a much better bet."

To me that showed a pretty high degree of statistical nous (though perhaps I should not be surprised; it is perfectly possible that your London Uber driver was formerly a mathematics professor at the University of Irkutsk).

But there is a lesson here for anyone involved in business. The nature of any business relationship unavoidably changes over time – because the balance of probabilities changes. Any non-anonymous transaction involves more than the exchange of money; it also entails the exchange of an invisible and unquantified mental "trust currency". If I keep an Uber driver waiting on my first ever journey, the likelihood that I am a bad customer is quite high; on the other hand, if I force a 20-minute wait after a long, unblemished record of punctuality – well, he should probably forgive me that one.

RELATIONAL CAPITAL TRUMPS TRANSACTIONAL

Businesses need to reward customer loyalty if they want to keep them coming back

By Rory Sutherland

RORY SUTHERLAND

is vice chairman of Ogilvy & Mather Group



You could call this currency "the benefit of the doubt". Over time, we expect businesses to which we have been repeatedly decent to reflect that in their treatment of us. Loyal repeat customers instinctively believe that, with each transaction, the seller should add a mental credit to the favour-bank. If this tacit rule is broken, and the favour-bank proves to be empty, moral outrage may cause the scandalised customer to defect altogether – even at some cost to himself.

Commitment devices – Amazon Prime, Ocado on Demand, Asos Premier, or indeed the institution of marriage – provide a useful means for one party to a relationship to signal that they are prepared to commit to something lasting, rather than a series of one-off transactions. Far more businesses, I suspect, need to discover their equivalent of Amazon Prime.



Not all business relationships are like this. If I stop and buy a newspaper at a motorway service station, I regard that as a fairly anonymous, stand-alone exchange – what you might call "transactional capitalism". On the other hand, the relationship I have with my local pub landlord or even Uber is different. There I expect the sum of my past transactions to be implicitly reflected in the conduct of future business. This is, in effect, "relational capitalism".

When you understand "relational capital" more clearly, you see business differently.

Suddenly, you understand why the most common opening to letters of complaint (say to a phone or cable company) is the sentence "I have been a customer of yours for X years", even though in strictly economic and legal terms (contracts are usually for 12 months) this information is completely irrelevant.

You understand why a customer complaint which is handled well can result in the customer becoming more loyal than they were before the problem. (Your reserves of corporate decency have been tested and not found wanting.)

You understand why BA Executive Club members felt somehow violated when their "Tier Points" were reset to zero every year. You had flown with the airline ten times a year for 15 years, yet at the end of each year your status was effectively reset to "random tourist". The airline now records and displays your "Lifetime Tier Points" when you log in. (Disclaimer: British Airways is a client of Ogilvy, of which I am vice chairman.)

Above all, you know why it matters so much to people that a publican or restaurant owner greets them by name. Recognition matters. There is nothing to be gained from doing favours for an amnesiac.

It is vital that the nature of this tacitly understood mechanism is better appreciated by the people who design software and technology. Currently, the focus is on the efficient processing of individual transactions. Yet digital transactions are recorded – and customers know this; they thus expect loyalty to be recognised. The design of online businesses needs to reflect this.

Take Uber's Surge Pricing. If Uber recognised lifetime customer value, it would not impose this so indiscriminately. As the behavioural economist Shlomo Benartzi and I concluded during a long dinner, Uber could



UBER EXPANDS

Taxi-hailing platform Uber says it will invest more than \$1bn in India by March 2016. It plans to use the cash injection to triple its staff and beat the competition of Indian taxi app Ola. Uber's target is expanding its operation to 40 Indian cities. **GV**

simply offer customers one "out" every 20 journeys – customers could use these to cancel out surge pricing on critical journeys. This would reduce the outrage which Uber recently aroused during the Sydney hostage siege.

The same goes for Uber's minimum fare. If I spend £200 a month on Uber cars, it seems unfair if I am not entitled to take a £5 journey once in a while. Not every day, but sometimes.

Or, let's take a trivial but illustrative example from parking at my home town of Sevenoaks.

In the early days when I moved there, a man at the car park took your money as you drove in. He gave you change from a £10 note and – if he knew you – he would very occasionally allow you to park if you had no money, on the understanding that you would pay him back the following day. That was good.

Then came the next - and worst - phase of technology. A stupid pay and display machine which demanded seven pound coins. And entailed a walk back to your car to fix a sticker in your windscreen.

Now you can pay by mobile phone. That's better. But there is one thing missing: they know I spend £500 a year parking there. I know that they know. Yet if I forget to pay something which unavoidably happens once a year – they fine me £30. No warning note. No "We notice you forgot to pay – you owe us £4." Just a straight fine – just as someone would get who had parked there illegally who had never previously parked there legally. These fines, imposed by the council, are blamed by local tradespeople for destroying businesses in the town centre.

This violates all human instincts of fairness. A better system might be to offer me an Amazon Prime scheme where I pay £50 a year and save £1 a day on all parking. With the additional benefit that you are given one or two moments of grace every year at moments of memory loss.

When you design things for efficiency, the thing that gets lost is the need for forgiveness – for the-benefit-of-the-doubt.

There is one huge problem with ruthlessly efficient businesses. People really don't like them. Just as we design physical objects to fit the evolved shape of the human hand, we need to design experiences to fit our evolved psychology. In 2016, more and more technologists will find they have to be psychologists as well.



COLLABORATION IS THE SEASON'S NEW LOOK

The future of online retail will see businesses working together – even with competitors

By Natalie Massenet

FOR MANY DECADES, BUSINESS WAS ALL ABOUT

competition – enterprises operated under the principle that they needed to find and exploit a competitive edge to survive and there could be only one winner. Businesses big and small would use any advantage they had. In 2016, however, I believe there will be a shift: the most successful businesses will be characterised by collaboration between businesses in the same sector, different sectors or with their customers.

Innovation in technology has fundamentally changed the way businesses function and work with each other. It's no surprise, then, that the nature of competition has

NATALIE MASSENET

is chairman of the British Fashion Council. She founded Net-a-Porter in 2000



changed, driven by companies expanding their offerings along with diversifying and innovating in new sectors. Technology giants such as Google and Amazon are constantly moving into new areas. Who could have predicted that a search engine would be pioneering driverless car technology 17 years later? Or that an e-commerce bookshop would now be selling everything from furniture to fashion and testing drones for deliveries?

This blurring of boundaries means that businesses, especially online ones, no longer occupy one discrete sector within a single set of competitors. Competition comes not only from the other players in your space, but also from those in other sectors who see an opportunity. This change can be viewed as a threat, or people can collaborate and help create a bigger pie for everyone to have a share of.

This doesn't mean that competition is dead – far from it. Businesses should be their own greatest competition and be willing to disrupt themselves before someone else does. That was the thinking behind Net-a-Porter's launch of The Net Set social network in May 2015 – to move the store to where people are heading. When Net-a-Porter launched in 2000, its mission was to bring fashion to women at their desks or home through online shopping.

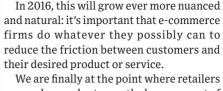


Today, in the age of social media, it is about joining the style conversation and the communities that gather and share online.

Social shopping is rapidly gaining momentum. Platforms from *Instagram* to Pinterest influence how consumers discover items and spend their money by making e-commerce about more than dropping items in a virtual shopping cart. Consumers can shop with friends, and have a personal dialogue with the brands they love. This evolution is making it possible to collaborate in a much more meaningful way.

Businesses working together is only one aspect of this increasingly collaborative economy - the consumer is best served if we collaborate with another supplier and directly with her or him. Fashion has moved from a one-way conversation where designers and magazines told the consumer what to buy to one that invites the consumer to shape the conversation and empowers them to make their own buying decisions.

For example, if a reader sees a Chanel top in a magazine and it's not yet available to buy online, the magazine should communicate directly with Chanel and find it at no extra cost. That might sound like sending profit elsewhere, but in fact it's a win for everyone involved. The customer is happy because she has her top and will no doubt return to the magazine. And Chanel is happy because the magazine has connected the retailer with a customer. In today's world, we need to collaborate to be able to compete.



We are finally at the point where retailers can analyse and act upon the huge amount of data that customer interactions create. In its simplest form, this is what everyone has been calling personalisation, but it could be so much more. Amazon, for example, made huge waves with its Anticipatory Shipping patent that predicts which products consumers will buy and ships them to a nearby hub, anticipating the purchase. Innovations like these tap directly into what people want: immediate, exceptional and personalised customer service that goes beyond marketing.

The early days of e-commerce were blighted by confusing, cluttered and unfriendly user experiences. Crucially, digital businesses lacked the intuition and basis common sense that a well-staffed bricks-and-mortar shop offered. That human touch, so often missing when we shop online, will become more present in 2016 as new technology dissolves outmoded business models. This new age of immediacy demands a rethink of this approach, especially as technology now caters for whatever we want at the tap of a screen. Competition creates win-lose scenarios, but collaboration benefits us all.



SMARTER CARS

Automaker Toyota will invest \$50m over five years to develop intelligent cars with Stanford University and MIT. Led by DARPA's former programme manager Gill Pratt, the project will focus on teaching vehicles to learn from human drivers. GV

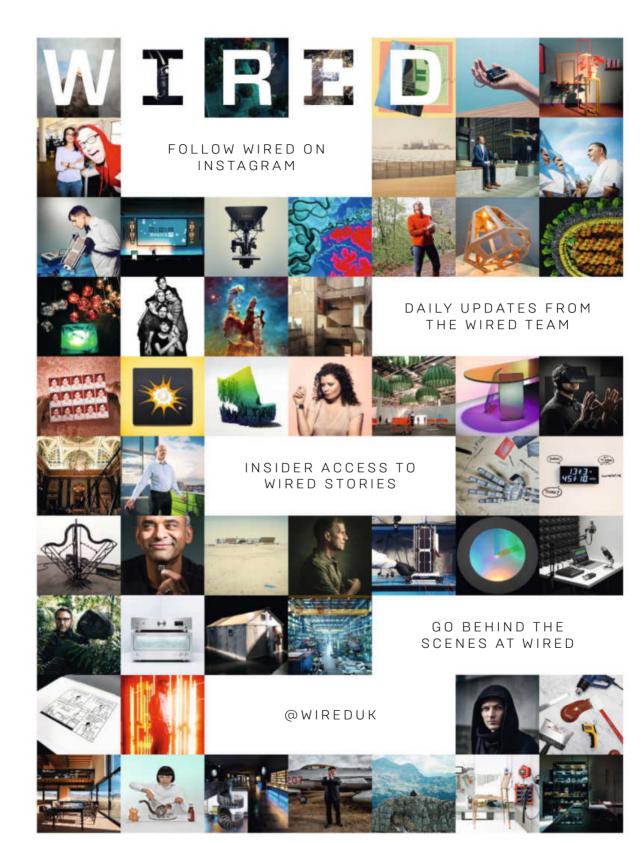
BYE-BYE, BLACKBERRY

It may be that no new BlackBerry phones are made in 2016. The CEO of RIM, the manufacturer of the onceubiquitous handset, has hinted that, barring a sudden surge in sales, hardware production will cease by 2017, RIM's core business would then be in providing security services to other platforms. The Canadian corporation, once a market leader, has struggled since the launch of the iPhone in 2007. Today, its market share has plummeted to 0.3 per cent, GV

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FROM VIRTUAL REALITY TO PROCEDURAL GAMING

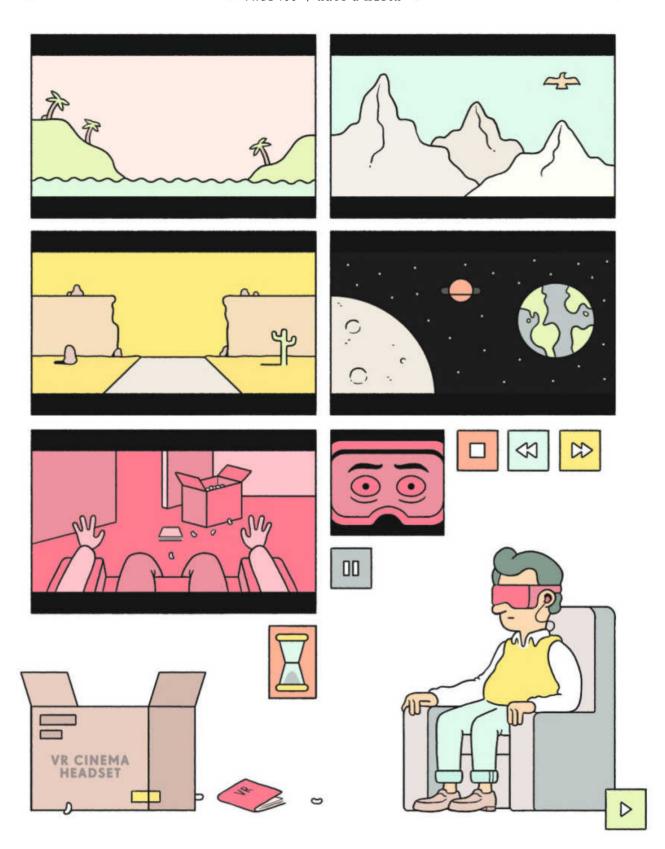


ARTS & MEDIA

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SPOT ILLUSTRATION:



PREPARE FOR IMMERSION: VIRTUAL REALITY BREAKS DOWN THE FOURTH WALL

Think you know VR? Wait and see what studios and film-makers have in store for 2016

By Oliver Franklin-Wallis

SO FAR, THE RISE OF VIRTUAL REALITY (VR) HAS

been driven by video games. Sony's PlayStation VR and HTC's Vive, made in partnership with Valve, are built by gaming companies; Palmer Luckey built the first Oculus Rift for gaming (and recently partnered with Xbox). But in 2016, as VR headsets become available to consumers – starting with Oculus in Q1 – other forms of entertainment will begin to break through. The most significant: film (no, not the adult kind). Not everyone plays games, but many go to the cinema and a majority watch TV. If VR is to reach mass adoption, it will be filmed content, rather than gaming, that fuels it.

Hollywood has been slowly catching on to the potential of VR. Major studios, from Fox to Paramount, have experimented with the form through tie-ins to established franchises,

OLIVER FRANKLIN-WALLIS

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from Interstellar to Game of Thrones. So far, few have been more than stunts. But with VR headset sales predicted to hit 12.2 million in 2016, according to investment bank Piper Jaffray, the industry is now taking it seriously. Head to major film festivals such as Sundance or Tribeca and you'll see scores of executives donning headsets to watch innovative, high-quality content being produced by indie filmmakers. VR tech companies have recognised the importance of video: in January 2015, Oculus launched its Story Studio, helmed by a former Pixar director, to produce film content for the platform.

"Film is an antiquated term. We call them 'experiences'," says Chris Milk, founder of LA-based VR production company VRSE.works. An artist and film-maker, Milk was an early innovator in VR cinema, having produced an acclaimed music video for Beck's "Sound and Vision". Taken by the form, he founded VRSE.works, which produces VR content for companies including Vice and NBC. A typical VRSE.works film is a thrilling experience: take Walking New York, a nine-minute documentary produced for The New York Times about the French street artist JR. The short opens with the viewer sat face-to-face with the artist in his studio; as JR speaks, the viewer is free to gaze around at his work littering the space. Later, you experience a 360° time-lapse shot from the centre of Times Square, as if reality itself is warped and distorted around you.

At its best, film-making for virtual reality is a giddying experience: in another of Milk's films, *Evolution of Verse*, the viewer is approached by an onrushing train. Watch someone viewing the scene for the first time to demonstrate the power of virtual reality: some flinch, others yell. (The fear is unfounded; at the moment of impact, the train explodes into a dazzling shower of birds.) "You can't make somebody's stomach spin with a traditional film," Milk says. "We're really playing with it. We're using how it makes you feel physically to tie in with how you feel about a character."

Film-makers are also coming to terms with VR's early limitations – for example, the frequent problem of content inducing motion sickness. "Your vestibular system registers acceleration and deceleration, but it doesn't tell you when you're already moving, which is why you can sit on an aeroplane and feel fine," says Milk. As such, VRSE.works' films now



use steady, slow tracking shots, rather than the jerky cuts typical of cinema blockbusters.

Such physical experiences are profoundly different to traditional cinema – and exciting for film-makers. "You can imagine a horror movie, for example, being a very powerful experience," says Jens Christensen, co-founder of VR startup Jaunt, which produces camera systems for VR and partners with film studios to produce content. "Nature is a great example – feeling transported to a dangerous environment where you wouldn't normally want to be, but the camera can be there, so you get up close and personal."

VR cinema will only reach its potential if the medium can attract the quality of storytellers that cinema does. As such, VRSE.works has partnered with Annapurna Pictures founder Megan Ellison, producer of Oscar-nominated films from *Zero Dark Thirty* to *American Hustle*, to create VRSE.farm, a lab that will help both established storytellers and first-time directors create content in the form. (Among the creatives involved

OCULUS BECOMES REALITY

Long-awaited virtual-reality headset Oculus Rift is due to be released in the first quarter of 2016. The brainchild of 23-year-old Palmer Luckey (see p24), Oculus is one of the first attempts to bring VR to the consumer market. Facebook acquired the company for \$2 billion in 2014. GV

is director Spike Jonze.) "We're having conversations with very notable film-makers, teaching them what we've learned," Milk says.

The physical challenges of shooting for virtual reality also present a set of previously unknown challenges: you can't have a traditional set when you can see in 360°. "It's learning things like, you can't have a dolly track underneath you in a VR shot, because you can look down," Milk says. Although early VR films were typically shot using cubes of GoPros, startups such as Jaunt now sell 360° camera arrays and binaural microphones.

Some hurdles, such as the sheer amount of data involved - from the rendering process to content delivery - will be harder to overcome. "Not only is the capture and post-production of the content hard, but so is the delivery, as the data for even a short immersive piece is huge," says Simon Robinson, chief technology officer for The Foundry, which produces digital tools for film-makers. But other challenges, such as developing industry-wide standards with several big players entering the market, are more modest, says Christensen. "If you think about what IMAX had to do, not only did it have to build cameras and create content, it had to actually build theatres," he explains. "Thankfully, though, we don't have to - the goggles will already be out there, driven at first by gaming."

"Right now there's not a mass audience you can monetise content to," Milk says. "But you'll start to see what feels like mass adoption towards the end of 2016, as everyone brings their content to market. Then things will begin to get exciting for us."

One thing that remains to be seen is how content will be consumed in VR; going to the cinema is a social experience, rarely a solitary one. "We do think the social experience is important – and that's why it's a great validation point that Facebook bought Oculus," Christensen says. "We think it'll start with people watching in your living room, but potentially in the future you might go to a place like a movie theatre and watch it with others."

One thing film-makers are clear on: although VR is certainly the future, don't expect it to replace the big screen. "It's not going to replace TV or movies. It's a new medium," says Christensen. Milk agrees. "It's like the beginning of cinema," says Milk. "The potential for storytellers is amazing."

Top left: in VRSE.works' Walking New York, the viewer can explore the space around street artist JR

X-FILES RETURN

-

Classic sci-fi series The X-Files will return on US channel Fox in January 2016. Series creator Chris Carter has written and directed three of the six new episodes, which will feature much of the original cast. Dana Scully and Fox Mulder will try to untangle some enigmas left unsolved more than a decade ago. Gian Volpicelli



IN 2016. BEAUTY WILL MAKE A COMEBACK IN DESIGN

and architecture. Pure, formal beauty is an ancestral human value: *Homo sapiens* wanted their stone axes to be perfectly symmetrical not for functional reasons, but because they would look prettier that way. It was a deliberate design choice that's exemplified by the creation of metre-tall axes that were too heavy to be used – they were merely ornamental.

From antiquity to the 19th century, beauty for beauty's sake was considered as important as moral goodness. We have been populating gravevards with beautiful objects (flowers, elaborate carvings and statues) for centuries, with the idea that this beauty might allow us to transform utter misery into something lighter, something like common sorrow. That sensibility changed after the first world war: beauty was sidelined as an artistic strategy. Think of Marcel Duchamp's urinal, Fountain, which was a statement that dismissed aesthetics in art. Or Bauhaus in Germany, which argued that, primarily, objects must function. Today, that mindset is still entrenched in design and architecture. Few designers would have the guts to present something and say, "Oh, I've done that because it's more beautiful!" Every design choice has to have an attached argument steeped in function.

This way of thinking is completely wrong: beauty is, in fact, part of the function. It's not by chance that an aesthetically aware company such as Apple has achieved such dominance. And, slowly, designers and architects are realising that beauty improves quality of life. For instance, New York's High Line park, which serves few practical purposes other than its aesthetic, has triggered a sort of virtuous cycle: the new buildings mushrooming around it are more beautiful than those you usually see in Manhattan. As beauty's real impact becomes clearer, we can expect more cases like this - 2016 could be a watershed year for decision-making based on aesthetics. A major example is Herzog & de Meuron's Philharmonic Hall in Hamburg. Although plagued by delays, it nevertheless exemplifies a gorgeous form: not only can the building be read as an emotional visualisation of the music it will house, it makes the viewer want to go inside and listen to it.

James Turrell's Skyspace at Rice University in Texas is another harbinger of the return of beauty. Viewed at dusk or dawn, it frames a

THE RETURN OF BEAUTY

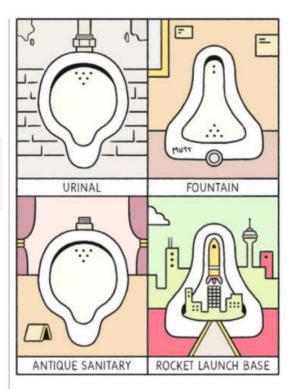
Beauty for its own sake will triumph over function. Just ask Apple

By Stefan Sagmeister

STEFAN SAGMEISTER

is co-founder of design firm Sagmeister & Walsh





section of the sky in such a mesmerising way that I've never again looked up with the same mindset. The National September 11 Memorial in New York City, designed by Michael Arad, is beautiful – and the beauty is functional. The masses of falling water eliminates all other noises and allows for real contemplation.

In a world in which we are overloaded with sensory information, beauty will be one of the most important ways that designers can differentiate their products and create wonder amid increasing complexity.

INDIE CINEMA'S SECOND ACT

Streaming giants Amazon and Netflix look set to give the movie industry a shot in the arm

By Matt Cowan

WHEN FILM BUFFS OF THE FUTURE LOOK BACK

to the year 2015, they may well wonder what happened to originality. From *Star Wars* (the JJ way!) to a *Jurassic Park* return of mammoth proportions, from *Mad Max* to *Terminator*, from *Avengers: Age of Ultron* to *Furious 7*, Hollywood seems stuck in a cinematic time warp. It's like television before HBO rewrote the rules – formulaic and in need of fresh thinking.

Enter the disrupters. Amazon and Netflix have already put their stamp on television – the online retailer earned a Golden Globe for its breakthrough comedy *Transparent*, and Netflix bagged a total of 34 nominations at the 2015 Emmy Awards for shows including *House of Cards, Orange is the New Black*, and newcomer *Unbreakable Kimmy Schmidt*. Reid Hastings's company is on track to become the number-one broadcaster in the US in 2016, according to online video advertising company Alphonso.

Now the focus of these two video-streaming pioneers is moving to the big picture.

In January 2015, Amazon announced it was setting up a new division dedicated to producing and acquiring about 12 movies per year. The films would each get a theatrical release before becoming available to subscribers to its streaming service, Amazon Prime, four to eight weeks later – far quicker than the 39 to 52 weeks it usually takes for films to premiere on subscription video services.

MATT COWAN

is director at media relations consultancy MediaWorks



Amazon said it hoped "this programme will also benefit film-makers, who too often struggle to mount fresh and daring stories that deserve an audience." The new original movies division of Amazon Studios gained instant clout by bringing in respected indie producer Ted Hope (American Splendor, The Brothers McMullen) to lead the original motion picture division. In June, it added fellow veteran Bob Berney to handle theatrical distribution and marketing.

"It was like, lock and load, here we go," says Dana Harris, editor of entertainment news site Indiewire. "It's just a behemoth getting into this space. It was welcomed, especially when they hired Bob and Ted. They are veterans in the space and they're known for being wily and smart and for their creative instincts. And that's going to be paired with algorithms."

Indie film by algorithm may sound like a sign of the apocalypse, but the encouraging news is that the tech players have seen our viewing habits and are jumping at the chance to invest in more adventurous fare. Amazon's first film to hit theatres will be Spike Lee's *Chiraq* (*below*), a musical comedy set in Chicago which Hope claims "may be [Lee's] greatest – and definitely his boldest – yet." Jim Jarmusch and Terry Gilliam have reportedly both been signed up to produce films for the fledgling studio, which also won a bidding war for the Kevin Spacey drama *Elvis & Nixon*.

Netflix, meanwhile, bankrolled a sequel to *Crouching Tiger, Hidden Dragon* and paid a reported \$12 million (£7.7m) for the rights to the Oscar-tipped war drama set in



Africa, *Beasts of No Nation*, starring Idris Elba. However, Netflix's plan to release it simultaneously via its streaming service and in theatres raised the ire of major US cinema chains, which have promised a boycott.

Although it hasn't earned quite the attention of its US counterparts, it's worth mentioning that the UK indie cinema chain Curzon has been a pioneer of the so-called "day and date" model, releasing films through its digital home-cinema service at the same time they debut in theatres.

"We're competing for people's time and that's going up against the gym, your kids, work – so giving people access to what they want, when they want, how they want it, is what this is all about," explains Philip Mordecai, who heads up the service. He says Curzon remains committed to the bricks-and-mortar cinema experience, but online is proving to be a solid vehicle for indie films in the UK. "I think it will be parity or more within three years," he says.

But will online platforms help revive the indie sector, which has struggled since its 90s heyday? "I don't think it's going to be a panacea – but frankly, whatever Amazon chooses to do will be educational, because they have so much data," Indiewire's Harris says. She believes that video on demand is going to be the future: "Film theatres are going to have a problem, because they're not the only game in town."

"A test of this kind of system is whether they support a guy like Hal Hartley," says Geoff King, who teaches film at Brunel University London. "Hartley is an indie hero, but he's struggled to fund every film he's made recently. It would be a good test of this – if they [will] fund an awkward, prickly Hal Hartley film, rather than just funding *Crouching Tiger Part 2.*"

If that's a measure of success, then there's reason for optimism. Amazon's new film honcho Ted Hope got his break producing Hartley films. In his memoir *Hope For Film* he recounts a realisation after the low-budget *The Unbelievable Truth* was picked up by Miramax. "It was the first time I thought that maybe it was possible, that maybe I, and others like me – people without connections or money – could not only make movies for our living, but also get them seen. And maybe we could change the world a little bit by what we made."

And now he has a data-powered technology platform and significant budgets at his disposal. What happens next in the industry will definitely be worth watching.

THE PROCEDURAL GENERATION GAME

Algorithms are on hand to help create new gaming worlds

By Oliver Franklin-Wallis

OLIVER FRANKLIN-WALLIS

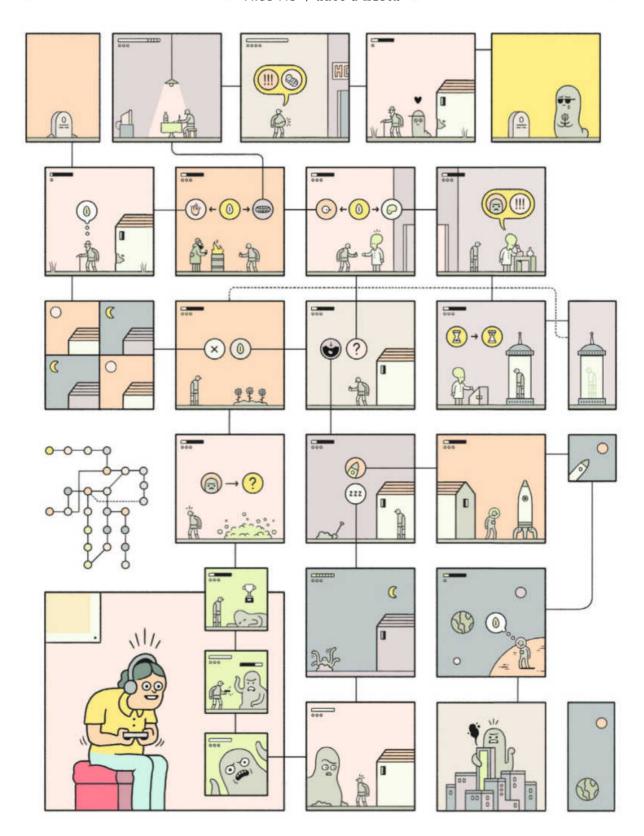
is assistant editor at WIRED



PRODUCING A BLOCKBUSTER VIDEO GAME -

so-called "AAA" titles such as *Call of Duty* or *Uncharted* – is an expensive and labour-intensive process. (Bungie's *Destiny*, released in 2014, cost an estimated \$500 million [£323m] to develop.) In 2016, however, a new type of video game will take centre stage: one whose immersive worlds are created not by developers, but by algorithms. Using programmatic generation, games will become larger and more varied than ever while slashing the costs of entry for independent developers.





Programmatic generation isn't new to gaming. In the 80s, classic titles such as *Elite* used algorithms to create its simple blocky environments, such as planets or asteroids. Modern titles already use it to create the kind of mass details required by games: weapons, plant life or the faces of orcs.

But now, inspired largely by the blockbuster success of *Minecraft* – which uses programmatic generation to create its block-filled worlds – a new wave of developers is adopting the technique in bigger and more inventive ways. The most high-profile of these: PlayStation 4 title *No Man's Sky*, created by Guildford-based developer Hello Games, which uses algorithms not to create a world, but an entire universe. *No Man's Sky* claims to contain the potential to generate an astonishing 18,446,744,073,709,551,616 planets for players to explore.

"Right now, if you have a game idea and it's set in a city, then you are going to need hundreds of artists to build that city by hand. It's why sequels are so common and real innovation is very rare," says Hello Games founder Sean Murray, 35. "Procedural generation allows us, a little team in Guildford, to build an incomprehensibly big universe filled with a huge amount of variety."

Procedural generation has been embraced by the space genre – *Elite: Dangerous* and *Star Citizen* both use the technique to populate their universes – but it's not the only category jumping on board. Indie developers have used the tool as a means to create huge, enveloping worlds at a fraction of the cost of AAA titles. Games such as *Terraria* and *Salt* create new worlds and stories for players to explore on each play; *Stranded Deep* creates an ocean of desert islands, which the player must survive by adapting (think *Castaway*, but bleaker).

It's not just environments, either: in *Rimworld*, an "AI storyteller" creates events and mini-narratives for the player; *Moon Hunters* uses the technique to create "myths" – in-world stories and art – about the player's exploits; and in *SkySaga: Infinite Isles*, a role-playing game by UK-based Radiant Worlds, entire adventures are generated by algorithm. "We wanted to give the player something new to play with every time," says design director Ben Fisher, 34. "We want *SkySaga* to become what we call an anecdote engine: where the unique combination of circum-

stances turns into a story that nobody else has experienced, and you're eager to share."

Algorithms as designers has the potential to turn the whole notion of developing on its head. "Our art director is used to just creating beautiful art, then exporting into a game," says Murray. "I have to analyse why flowers grow at the base of trees in a meadow, and come up with a formula that would cause this to happen."

"Another disadvantage is that you can't directly tailor the player's experience – a great deal of the skill in game design comes down to tuning the player's emotional journey," says Fisher. "It may sound counter-intuitive, but a lot of effort has gone into figuring out exactly how much you have to group and filter content to stop it feeling too random."

Algorithms are also dumb, which means extensive testing and tweaking. "When *Minecraft* generates a breathtaking waterfall, it doesn't actually know this has happened," says Michael Cook, 27, a procedural generation researcher and founder of PROCJAM, an annual UK-based industry event. "A major challenge is building software that is good at analysing, critiquing and understanding what it's made."

Still, with improvements in graphics – traditionally used to sell gamers newer titles – slowing relative to spiralling costs, procedural generation poses the prospective of a revolution. Soon, more games will no longer be limited to pre-scripted, film-like experiences, but will contain entire universes; developers won't be sculpting, but playing God.

"It's a fraught process, one which requires programmers to be much more visually motivated than usual," says Murray of *No Man's Sky*. "But the pay-off is seeing flowers sprout up around the base of every tree in every meadow across an infinite universe."



SOCIAL Newsroom

NEWSROOM
Snapchat is

planning to deploy its own iournalistic team to cover the 2016 US presidential election. The messaging app published a job ad for political analysts in May 2015, with the goal of covering the presidential race and events such as the Oscars. Snapchat hired CNN senior political reporter Peter Hamby in April 2015. GV

POKÉMON ON YOUR SMARTPHONE

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Nintendo and Google spin-off Niantic have created Pokémon Go, an Android and iOS game that uses augmented reality to allow people to catch, fight and trade the cute monsters in real life. The app

- Nintendo's first foray into smartphone gaming
- is due in 2016, and will work with a wearable
- "Pokéball" device for detecting the critters. GV

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